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Productivity Teams

Gossip in steelfoundry circles reveals that the report resulting from the visit of the " productivity team " to the United States has been distinctly useful. A very bulky document has resulted from this visit and every foundry has benefited from the study of one or more sections. Because it was the first team to leave these shores it received some excellent publicity, which has done much to demonstrate to the public in general that steelfounding is indeed a go-ahead industry. Moreover, as a team, it was fortunate in the choice of Mr. F. A. Martin, O.B.E., as its leader, for we are convinced that much of the success depends on the personality of this officer.

Now, members of the ironfoundry industry are wondering whether they too should not organise a team. They are cognisant that, already, many of their colleagues have been privileged to visit a representative selection of American ironfoundries, and much has been published of their observations. They are also well aware of the fact that from their very nature they vary enormously as to their technical requirements. The maker of automobile cylinders, for example, is not going to derive direct benefit from a visit to a machine-tool, a roll, or an ingot mould foundry, and *vice versa*. Such visits, however, are useful as there are the general questions of the stock yards, melting plant, technical control and costing. Finally, a major difficulty would be the choice—unless it be an excessively large team—of a group representative of a true cross-section of the industry. Because there has been such freedom amongst ironfounders to visit each other's works, it might be possible to select a team possessing real knowledge of British industry, but, failing this, an extensive tour of national enterprises should be undertaken by members of the team. It is only too easy to make the mistake of purchasing a long report of a technique seen abroad which has been practised in this country for a long period. This is not unusual.

On the other hand, factors in favour of organising a productivity team for ironfounders include those of prestige, of learning more about mechanical handling, the implementation of unified costing systems, technical developments and control, good house-keeping, salesmanship and general questions of marketing. Consideration would have to be given to the scope of the report, for the ironfounding industry being so very much larger than that employed in making steel castings, any report emanating from the former section would obviously assume unwieldy proportions. It would appear that the best benefits would accrue from sending groups representing the various organised foundry interests such as jobbing, textile, motor vehicles, machine tools, rolls and so forth. From our knowledge of the French foundry industry we suggest quite seriously that an Anglo-French productivity team be formed. From personal observation we are convinced that we have much to learn from each other, and this at great saving in time and cost as compared with a transatlantic tour, even though American practice is so well advanced and so very interesting. There is, for instance, the increased speeds at which the overhead cranes service the shops; mechanised analysis service; foundry equipment; research work; apprenticeship training, which runs on lines quite different from ours, and pattern equipment. Whether or not the devaluation of sterling will make the cost of such trips too high, except for Government delegations, remains to be seen. On the other hand, we can welcome visitors from the States, who will find living expenses quite cheap here, and, after all, visitors do teach as well as learn.

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Forthcoming Events

(Secretaries are invited to send notices of meetings for inclusion in this column)

SEPTEMBER 24.

Institute of British Foundrymen.

East Midlands Branch :—Visit to Renishaw Iron Company, Limited; Presidential address.

SEPTEMBER 26.

Institution of Production Engineers.

Manchester Section :—" Education for Management," by L. Urwick, O.B.E., at the College of Technology, Sackville Street, Manchester, at 7.15 p.m.

SEPTEMBER 27.

Institute of Industrial Supervisors.

West Bromwich Section :—Inaugural meeting, at the Grammar School, West Bromwich, at 7.30 p.m.

SEPTEMBER 28.

Institute of British Foundrymen.

Birmingham Branch :—Presidential address; " Can Malleable Irons be Manufactured at Reduced Cost? " by S. W. Palmer, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 7 p.m.
London Branch :—Presidential address; " Some Modifications in Cupola Design," by E. S. Renshaw and S. J. Sargood, at the Waldorf Hotel, Aldwych, W.C.2, at 7 p.m.

Institution of Production Engineers.

Manchester Section :—" Developments in Oxygen Cutting," by E. Ryalls, at the Mechanics' Institute, Crewe, at 7.15 p.m.
Shrewsbury Sub-section :—" Electronics in Industry," by A. S. Dale, at the Technical College, Shrewsbury, at 7.30 p.m.

Institute of Industrial Supervisors.

London Central Section :—Inaugural meeting, at the Polytechnic, Regent Street, W.1, at 7.30 p.m.

SEPTEMBER 29.

Institute of Industrial Supervisors.

Dudley and District Section :—Inaugural meeting, at the Dudley and Staffordshire Technical College, at 7.30 p.m.

SEPTEMBER 30.

Institute of British Foundrymen.

Falkirk Section :—" Production of Grey-iron Castings," by C. R. van der Ben and H. Haynes, at the Temperance Café, Lint Riggs, Falkirk, at 7 p.m.

OCTOBER 1.

Institute of British Foundrymen.

Lincoln Branch :—Visit to Harrison & Company (Lincoln), Hykeham; Presidential address.

Institution of Production Engineers.

Yorkshire Graduate Section :—Film : " Mechanical Handling," at the Technical College, Bradford, at 2.30 p.m.

Obituary

MR. NORMAN WILSON, who died recently, was chairman of Gilbert Gilkes & Gordon, Limited, turbine and pump makers, and ironfounders, of Kendal, Westmorland, from 1920-34. Mr. Wilson, who was 80, was Mayor of Kendal from 1928-30 and a magistrate for 40 years. One of his three sons, Mr. Paul N. Wilson, who is now managing director of Gilbert Gilkes & Gordon, is prospective Socialist candidate for Westmorland.

Foundry Information Service

Birmingham Luncheon

The Foundry Information Committee, inaugurated more than a year ago to publicise the work of Britain's foundries and to encourage the recruitment of youth into the industry, held an informal luncheon party at the Midland Hotel, Birmingham, last week. The object of the meeting was to bring together the leading foundrymen of the area to discuss the best methods of achieving the right kind of publicity for the industry.

Those present included Mr. D. Howard Wood, Past-President of the Institute of British Foundrymen, who is chairman of the committee; Mr. Barrington Hooper, C.B.E., managing director of the FOUNDRY TRADE JOURNAL; Mr. A. M. Wormleighton, Association of Bronze and Brass Founders; Mr. A. Graham, Light Metal Founders' Association; Mr. J. W. Gardom, chairman, Midland Ironfounders' Association; Mr. E. Player, Sterling Metals, Limited; Mr. A. E. Pearce, Midland Motor Cylinder Company, Limited; Col. C. Lindop, H. W. Lindop & Sons, Limited; Mr. Wilfred Harper, John Harper & Company, Limited; Mr. T. Littlewood, Sandwell Casting Company; Mr. J. W. Berry, Birmingham Aluminium Casting (1903) Company, Limited; Mr. H. W. Redshaw, Qualcast (Crane), Limited; Mr. C. L. Bettinson, Hill Top Foundry Company, Limited; Mr. R. Forbes Baird, Midland Ironfounders' Association; Mr. J. J. Sheehan, Coneygre Foundry, Limited; Mr. Sydney Walton, and Mr. Gordon West, news editor of the Foundry Information News Service.

Apologies for absence owing to urgent prior engagements were received from Mr. V. C. Faulkner, Editor, FOUNDRY TRADE JOURNAL; Mr. T. H. Summerson, British Steel Founders' Association; Mr. T. Makemson, M.B.E., Foundry Information Committee Secretary; Mr. F. N. Lloyd, F. N. Lloyd & Company, Limited, and Mr. J. F. Paige, William Mills, Limited.

Aims of the Service

Mr. D. Howard Wood, as chairman of the meeting, outlined the aims of the organisation, which is sponsored by Industrial Newspapers, Limited, and which involves no cost to the foundry industry. He stressed the importance of drawing the attention of the British public, as well as of the public of other countries, to the great work of the industry.

Mr. Barrington Hooper, supporting Mr. Wood, urged that everything possible should be done to awaken the interest of youth, as well as of the public generally, in the importance of the industry as offering a fine career, and generally to stress the importance of the industry and its achievements, through newspapers, radio and films. All of this could be done through the Committee and its associated technicians.

An informal round-the-table discussion followed, with excellent results. It was agreed that the Information Committee should be kept informed of developments in the foundries concerned, so that more comprehensive information of foundry achievements could be circulated. Lunch meetings are to be held periodically in other foundry areas.

Effect of Grain Shape on the Behaviour of Synthetic Core and Moulding Sands*

By W. J. Rees, O.B.E., D.Sc.Tech., F.R.I.C.

Summary

The influence of grain shape on the behaviour of synthetic moulding and core-sand mixtures bonded with clays, core oils and core compounds has been investigated using a recently developed method for the assessment of grain shape. Typical examples of the effect of grain shape on the properties of the bonded-sand mixtures are given, and it is shown that for sands having comparable mechanical gradings the strength of mixtures prepared with angular sands is lower than that of mixtures based on rounded sands, and that the surface friability of the dried mould or core increases with the angularity of the sand.

Introduction

During the recent war it became urgently necessary to cut down wherever possible the distance over which sand was transported from the quarry to the user. As a result of the investigations and recommendations which were made a very considerable reduction in ton-mileage was effected without detriment to the production of steel and castings.

At one important ironfoundry silica sand from a considerable distance was being used for core-making and a recommendation was made that a trial should be made of silica sand from a much nearer source of supply. In sieve grading, chemical analysis, etc., the recommended alternative sand was quite comparable with the sand in regular use, but the dry tensile strength of oil-bonded cores produced from it was very much lower than similar cores made from the regular sand; so much so, that the use of the alternative core sand was impracticable. The ordinary laboratory tests on the two oil-bonded core sands gave no satisfactory clue to their very different strengths; it was found, for example, that despite its similar grading the specific surface of the alternative sand was greater than that of the regular sand, but a relative increase in the proportion of core oil gave only a small increase in the low tensile strength. Examination under a low-power magnifying lens showed that the grains of the alternative sand were rather angular whilst those of the satisfactory regular sand were decidedly rounded. After extended tests it became apparent that the difference in grain shape of the two sands must be the primary reason for their very different behaviour in

*Presented at the 46th Annual Conference of the Institute of British Foundrymen, at Cheltenham.

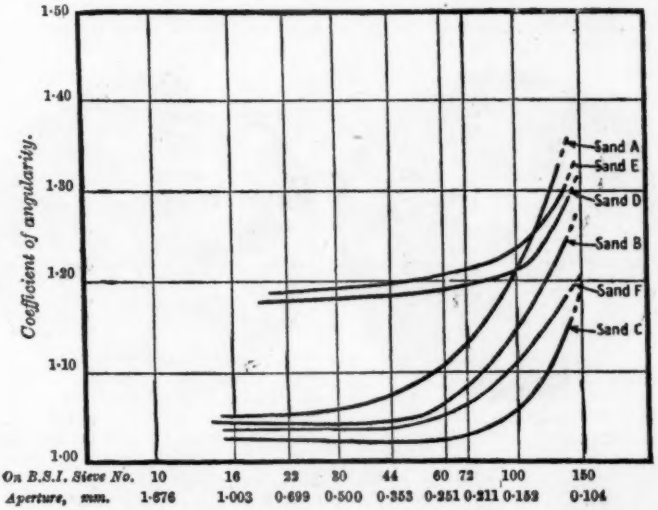

FIG. 1.—VARIATION OF COEFFICIENT OF ANGULARITY WITH GRAIN SIZE FOR UNCONSOLIDATED SANDS (REF. TABLE I).

Effect of Grain Shape

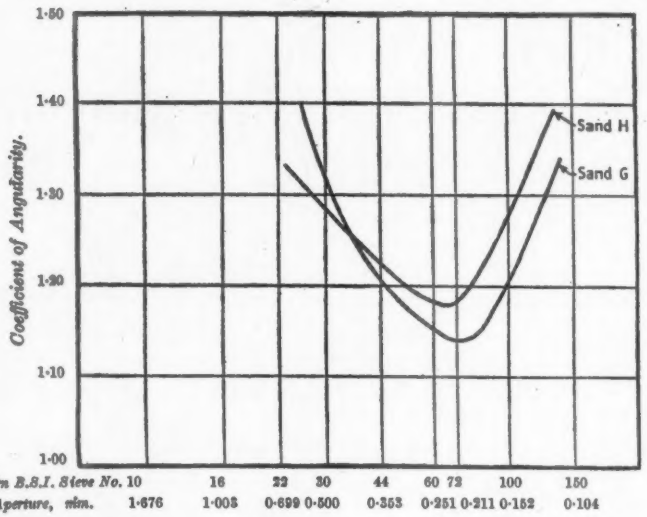

FIG. 2.—VARIATION OF CO-EFFICIENT OF ANGULARITY WITH GRAIN SIZE FOR CRUSHED SAND-STONES. (REF. TABLE II.)

oil-bonded core sands. Other types of core-binder were used in the extended laboratory tests to make comparisons with the special core oil in use at the foundry, but without exception the tensile strength of the cores produced from the alternative was very low. In these and the subsequent investigations the Author had the valuable assistance of Dr. W. Davies, M.Sc., F.G.S.

Determination of Grain Shape

Attention was directed to a method recently developed by H. S. Robertson and B. Emodi (Nature, 1943, 152, p. 539) for comparing the shapes of sand grains based on the determination of the specific surface (*i.e.*, the surface area of unit weight of the grains). Possibly the best of the older methods of measuring the specific surface of a system of particles is that proposed by H. Heywood (Proc. Inst. Mech. Eng., 1933, *125*, 383), but this method is rather tedious and does not lend itself to routine determinations. More recently another approach to the determination of specific surface has been made by P. C. Carman (I. Soc. Chem. Ind., 1938, *57*, 225; 1939, *58*, 1), who

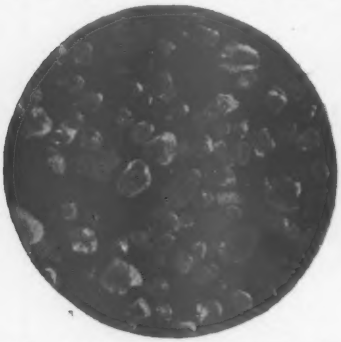

FIG. 3.—SAND A: AVERAGE CO-EFFICIENT OF ANGULARITY, 1.14. REFLECTED LIGHT. × 15.

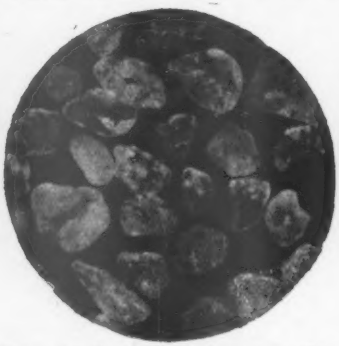

FIG. 4.—SAND B: AVERAGE CO-EFFICIENT OF ANGULARITY, 1.05. REFLECTED LIGHT. × 15.

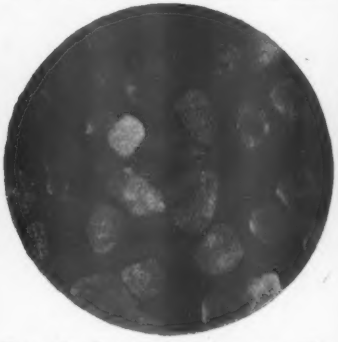

FIG. 5.—SAND C: AVERAGE CO-EFFICIENT OF ANGULARITY, 1.03. REFLECTED LIGHT. × 15.

FIGS. 3 AND 4.—EXAMPLES OF SANDS TRANSPORTED BY RIVERS AND DEPOSITED ON THE SEA FLOOR. FIG. 5 SAND ACCUMULATED AS A DUNE SAND UNDER DESERT CONDITIONS.

showed that a granular bed of particles had a permeability to a liquid which is related to the porosity of the bed and to the specific surface of the particles composing it. The permeability and the porosity are readily measurable, so the third variable may be obtained from this relationship. F. M. Lea and R. W. Nurse (J. Soc. Chem. Ind., 1939, *58*, 277) modified this method so that a gas could be used in place of a liquid, and this was used by Robertson and Emodi as the basis for the determination of a coefficient of

TABLE I.—*The Characteristics of Some Unconsolidated Sands.*

A. *Mechanical Grading.*

On B.S.I. Sieve No.	Sand A.	Sand B.	Sand C.	Sand D.	Sand E.	Sand F.
5	0.0	0.0	0.0	0.0	0.0	0.0
8	0.2	0.0	0.0	0.0	0.0	0.0
10	0.2	0.1	0.0	0.0	0.0	0.0
16	0.6	2.0	0.0	0.0	0.2	0.1
22	1.1	4.9	0.0	2.5	0.3	0.2
30	2.5	18.0	4.4	10.5	1.3	1.3
44	6.7	49.3	38.1	32.8	7.6	7.0
60	20.0	22.1	44.7	39.7	46.2	26.5
72	21.2	2.3	9.6	6.2	14.0	22.5
100	27.2	0.8	2.6	6.4	20.8	25.0
150	10.8	0.3	0.3	1.8	7.8	14.1
Pass 150	9.5	0.2	0.3	0.1	1.8	3.3
Total ..	100.0	100.0	100.0	100.0	100.0	100.0

B. *Coefficient of Angularity.*

On B.S.I. Sieve No.	Sand A.	Sand B.	Sand C.	Sand D.	Sand E.	Sand F.
16	—	—	—	—	—	—
22	1.05	1.04	1.02	—	—	—
30	1.06	1.05	1.02	1.17	1.19	1.04
44	1.06	1.05	1.02	1.18	1.19	1.04
60	1.09	1.04	1.02	1.18	1.20	1.06
72	1.10	1.08	1.03	1.19	1.21	1.06
100	1.12	1.11	1.04	1.20	1.22	1.09
150	1.18	1.21	1.11	1.25	1.28	1.15
Average (weighted)	1.14	1.05	1.03	1.17	1.19	1.08

TABLE II.—*The Characteristics of Sands Derived from Crushed Sandstones.*

A. *Mechanical Grading.*

On B.S.I. Sieve No.	Sand G.				Sand H.	
	Coarse.	Medium.	Fine.	Fine.	Medium.	Coarse.
5	0.0	0.0	0.0	0.0	0.0	0.0
8	0.1	0.0	0.1	0.0	0.0	0.0
10	0.1	0.0	0.1	0.0	0.0	0.0
16	0.8	0.2	0.4	0.0	0.6	1.7
22	4.2	0.3	0.5	0.1	4.9	8.1
30	11.3	0.9	0.9	0.4	10.6	19.0
44	22.8	3.7	2.4	8.5	18.7	21.4
60	34.4	15.3	5.9	19.3	23.0	18.0
72	12.8	14.2	7.0	21.0	15.4	11.1
100	8.5	25.7	22.5	34.5	18.9	14.4
150	3.6	24.8	34.0	15.0	6.7	5.5
Pass 150	1.4	14.9	26.2	1.2	1.2	0.9
Total ..	100.0	100.0	100.0	100.0	100.0	100.0

B. *Coefficient of Angularity.*

On B.S.I. Sieve No.	Sand G.				Sand H.	
	Coarse.	Medium.	Fine.	Fine.	Medium.	Coarse.
16	—	—	—	—	—	—
22	—	—	—	—	—	—
30	1.31	—	—	—	1.39	1.39
44	1·25	—	—	—	1·26	1·23
60	1.19	1.20	1.20	1.19	1.19	1.17
72	1.15	1.17	1.18	1.14	1.13	1.13
100	1.22	1.23	1.25	1.16	1.14	1.14
150	1.39	1.33	1.36	1.25	1.30	1.28
Average	1.24	1.24	1.29	1.18	1.22	1.21

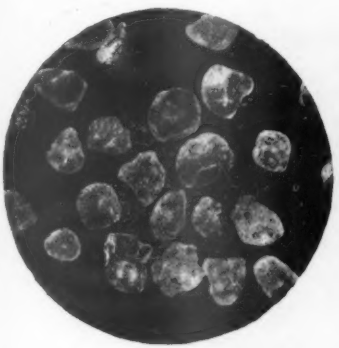

FIG. 6.—B.S.I. SIEVE FRACTION, −30/+44. COEFFICIENT OF ANGULARITY, 1.05. REFLECTED LIGHT. × 15.

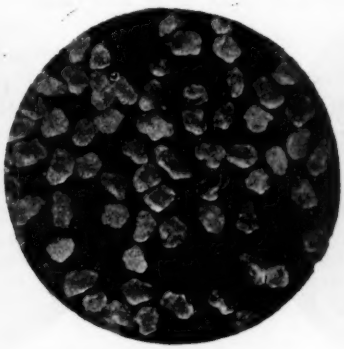

FIG. 7.—B.S.I. SIEVE FRACTION, −60/+72. COEFFICIENT OF ANGULARITY, 1.08. REFLECTED LIGHT. × 15.

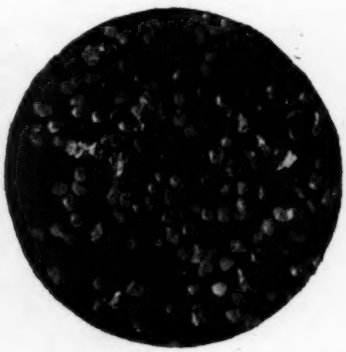

FIG. 8.—B.S.I. SIEVE FRACTION, −100/+150. COEFFICIENT OF ANGULARITY, 1.21. REFLECTED LIGHT. × 15.

FIGS. 6 TO 8.—VARIATION OF GRAIN SHAPE WITH GRAIN SIZE FOR SAND B. (FIG. 4).

Effect of Grain Shape

angularity (or rugosity). Following the determination of the specific surface, the specific surface of a similarly graded set of spherical grains can be calculated, and denoted the theoretical specific surface. Since a sphere has the least surface area per unit volume, it follows that the ratio of the actual to the theoretical specific surface cannot be less than unity and will become progressively greater than unity as the grain-shape departs further from the spherical. For a cube this ratio has the value of 1.25 approximately, whilst for a regular tetrahedron the value is about 1.49.

Details of the new methods on these lines for the determination of specific surface and the comparison of grain shape are given below. They have been extensively applied by the Author and W. Davies to the silica sands used in iron and steelfoundries, and it has been found in general that the grain shape varies with the grain size and that the nature of this variation depends on the mode of origin of the sand (*e.g.*, whether the sand was obtained from an unconsolidated deposit like the Lower Greensand of Leighton Buzzard or from the crushing of a consolidated deposit such as carboniferous sandstone. The mechanical gradings and coefficients of angularity of some unconsolidated sands are given in Table I and curves showing the variation of the coefficient with grain size are

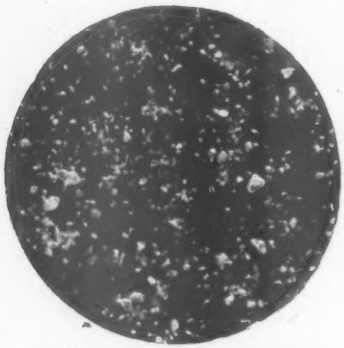

FIG. 9.—B.S.I. SIEVE FRACTION, −150. REFLECTED LIGHT. × 15.

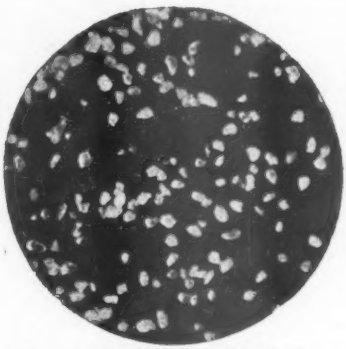

FIG. 10.—B.S.I. SIEVE FRACTION, −150 REFLECTED LIGHT. × 75.

FIGS. 9 AND 10.—VARIATION OF GRAIN SHAPE WITH GRAIN SIZE FOR SAND B. (FIG. 4).

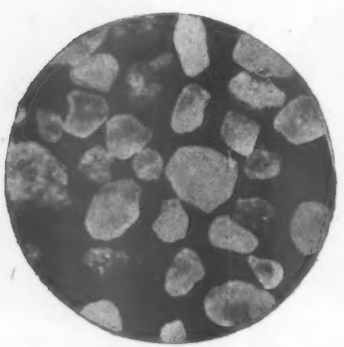

FIG. 11.—COARSE GRAINS OF SAND D. AVERAGE COEFFICIENT OF ANGULARITY, 1.17. REFLECTED LIGHT. × 15.

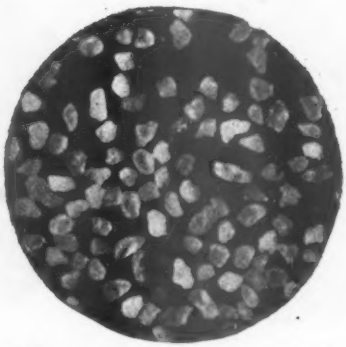

FIG. 12.—FINE GRAINS OF SAND D. AVERAGE COEFFICIENT OF ANGULARITY, 1.20. REFLECTED LIGHT. × 15.

FIGS. 11 AND 12.—SANDS CARRIED BY GLACIERS FOR CONSIDERABLE DISTANCES BEFORE BEING DEPOSITED.

shown in Fig. 1. Table II and Fig. 2 give similar data for sands produced by the crushing of sandstones.

Sand A (Fig. 3) and sand B (Fig. 4) were transported by rivers and accumulated on the sea floor, while sand C (Fig. 5) accumulated as a sand dune under desert conditions. In all three sands the larger grains are more rounded than the small ones, and the extent of this variation is illustrated by the micrographs, Figs. 6-10. Sands D and E (Figs. 11 to 13) were carried by glaciers for considerable distances before they were finally dumped at the end of the glacier by the melting ice. Sand F (Fig. 14) is rather more rounded than the waterborne sand A and sand B and was derived from the Triassic sandstones of Cheshire, and possibly Lancashire, by glacial action.

The sandstones from which the sands G and H are produced are composed of quartzitic aggregates, with some quartz grains which are not interlocked; they are crushed and the product is washed and graded. The composite character of some grains of sand G is illustrated by Fig. 15, and a typical section of the rock in Fig. 16; typical grains are shown in Figs. 17 and 18.

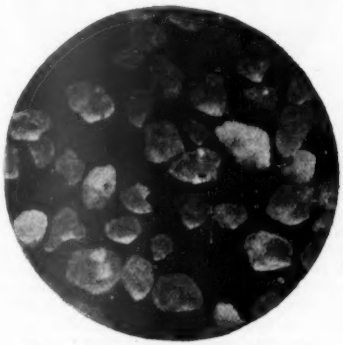

FIG. 13.—SAND E. AVERAGE COEFFICIENT OF ANGULARITY, 1.19. REFLECTED LIGHT. × 15.

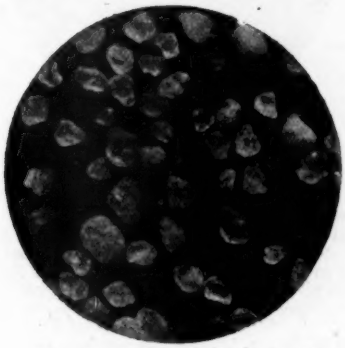

FIG. 14.—SAND F. AVERAGE COEFFICIENT OF ANGULARITY, 1.08. REFLECTED LIGHT. × 15.

FIG. 13.—SANDS CARRIED BY GLACIERS FOR CONSIDERABLE DISTANCES BEFORE BEING DEPOSITED.
FIG. 14.—SAND DERIVED FROM THE TRIASSIC SANDSTONES OF CHESHIRE AND, POSSIBLY, LANCASHIRE, BY GLACIAL ACTION.

FIG. 15.—GRAINS DERIVED FROM THE FRACTURE OF QUARTZITIC AGGREGATES; ONE GRAIN COMPOSITE, FORMED BY FRACTURE INDEPENDENT OF THE ORIGINAL GRAIN JUNCTIONS. SAND G. × 50, CROSSED NICOLS.

FIG. 16.—SECTION OF SANDSTONE H; WELL-DEVELOPED QUARTZITIC AGGREGATES WITH INTERSTITIAL KAOLINITE. × 30, CROSSED NICOLS.

Effect of Grain Shape

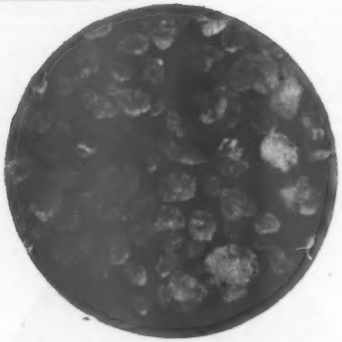

FIG. 17.—TYPICAL GRAINS FORMED BY CRUSHING AND WASHING SANDSTONE G. REFLECTED LIGHT. × 15.

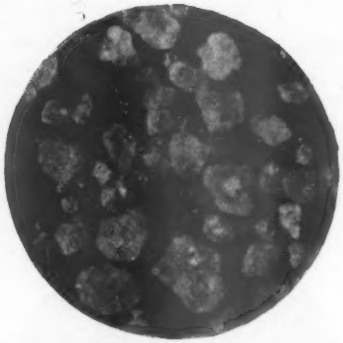

FIG. 18.—TYPICAL GRAINS FORMED BY CRUSHING AND WASHING SANDSTONE H. REFLECTED LIGHT. × 15.

Determination of the Specific Surface

The actual specific surface is determined by passing air through the sand arranged as a cylindrical bed with its axis in the line of flow. The specific *Sw* (sq. cm. per g.) is given by the following expression:—

$$S_w = \frac{1}{\delta(1-\epsilon)}\sqrt{\frac{\epsilon^3 . A . p_1}{K . \eta . Q . L}} = \frac{14}{\delta(1-\epsilon)}\sqrt{\frac{\epsilon^3 . A . p_1}{C p_2 . L}},$$

where :

δ = density of sand = 2·65 g. per c.c.
ϵ = fractional porosity of the bed = volume of pore-space/volume of bed.
A = cross-sectional area of the bed (sq. cm.).
L = length of the bed (cm.).
p_1 = pressure difference between the ends of the bed (dynes per sq. cm.).
[K = a constant = 5·0 (independent of both the particle shape and the apparatus).
η = viscosity of the air.
Q = rate of air flow through the bed (c.c. per sec.).
c = flow-meter constant.
p^2 = pressure difference on flow-meter (dynes per sq. cm.).

For the mathematical development of this expression see the above-mentioned Papers by Carman and by Lea and Nurse.

Carman verified the expression for a wide variety of shapes ranging from spheres to short, crimped lengths of wire. The apparatus is shown in Fig. 19. The air is passed from a reservoir (not shown) through concentrated sulphuric acid by means of sintered glass bubblers, and it is then passed through the sand bed contained in an inverted glass burette. The pressure difference across the bed (p_1) is recorded on a manometer. The principle underlying the flow-meter is that the rate of flow through an orifice is proportional to the pressure difference across the orifice. In the meter employed, the orifice was formed by a 2-m. length of capillary tube of 1-mm. bore.

The effect of surface roughness of the grains on the specific surface was found to be slight in a series of experiments made by Dr. W. Davies on an inorganic salt crystallising as rectangular prisms. First of all, the specific surface of the salt was calculated from the dimensions of the prisms, measured microscopically, on the assumption that they were smooth prisms of square cross-section; over a thousand grains were measured for this purpose. Actually the grain surfaces were as rough as those of most quartz grains.

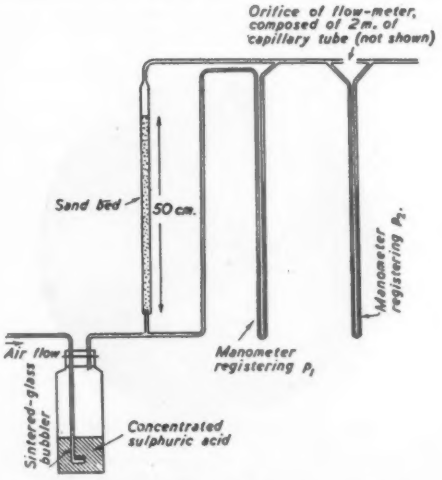

FIG. 19.—APPARATUS FOR DETERMINING SPECIFIC SURFACE.

Secondly, the specific surface was determined by the air permeability method. The calculated and determined values agreed to within 3 per cent., from which it appears that the effect of surface roughness on the specific surface must be slight.

On the other hand, if the grain surfaces are dusty, the specific surface is appreciably increased. In the determination of the coefficients of angularity, the sand was washed to remove the clay and silt.

Moulding Properties of Angular and Rounded Sand Grains

To compare the effect of grain shape on moulding properties a series of tests were made with sand F (Table I) with a coefficient of angularity of 1.08 (*i.e.*, rounded grains) and sand N of similar grading but with a coefficient of angularity of 1.20 (*i.e.*, angular grains); the respective specific surfaces being 116.0 and 117.0 sq. cm. per gm. Each sand was bonded with 5 per cent. Fulbond I and the A.F.S. test-pieces were rammed 10 times; the results of the tests being given in Table III.

TABLE III.—*Sands Bonded with 5 per cent. Fulbond No. 1. A.F.S. Test-pieces Rammed 10 Times.*

Sand N.

Moisture content, per cent. ..	1.5	3.0	4.0	5.0
Bulk density, g. per c.c. ..	1.66	1.67	1.70	1.71
Permeability number	131	127	110	100
Green strength, lb. per sq. in...	4.8	3.9	2.8	2.0
Dry strength, lb. per sq. in. ..	18	25	38	51

Sand F.

Moisture content, per cent. ..	2.5	3.0	4.0	5.0
Bulk density, g. per c.c. ..	1.67	1.68	1.71	1.73
Permeability number	127	124	100	95
Green strength, lb. per sq. in...	10.5	7.8	5.8	4.6
Dry strength, lb. per sq. in. ..	34	41	56	70

It will be seen that for a given moisture content, both the green and dry strengths of the F sand mix are decidedly higher than those of the N sand mix.

Similar comparative tests were made with other pairs of sands having closely comparable gradings but differing coefficients of angularity, the bonds used being either Fulbond or Bentonite. The results of these tests confirmed those given in Table III, in each pair of tests the green and dry strengths for a given moisture content being higher with the rounded grain sand that with the angular. There was also a marked tendency for the edges of the test-pieces made from the angular grain sand mixes to be more friable than those of the rounded grain sand mixes.

In comparing the effect of varying sand grain shape on the strength of core sands with organic bonds the tensile strengths were determined on the baked test-pieces and the results of tests made with sand B (Table I) with a coefficient of angularity of 1.05 and a sand P.1 having a closely comparable grading but a coefficient of angularity of 1.19 are given in Table IV below:—

TABLE IV.—*Baked Core Tensile Strength of Two Sands.*

Bond.	Lb. per sq. in.	
	B.	P.1.
2.5 per cent. core oil ex iron foundry	225	90
4.0 per cent. blackcore compound plus 0.6 per cent. moisture	250	160
4.0 per cent. semi-solid core compound plus 0.6 per cent. moisture	210	120

In each case the tensile strength of the angular grain sand mix is lower than that of the corresponding rounded grain sand mix, though the difference is not quite so marked with some bonds as with others.

Tests were also made with these two core sands in which the core oil was increased by stages from 2.5 to 4.0 per cent. and the results are given in Table V below:—

TABLE V.—*Baked Strength with Increasing Core-oil Percentages.*

Core oil, per cent.	Lb. per sq. in.	
	Sand B.	Sand P.1.
2.5	225	90
3.0	245	135
3.5	270	180
4.0	295	220

It will be seen that the proportion of core oil with the P.1 sand has to be increased to 4.0 per cent. before its tensile strength is equal to that of the B sand with 2.5 per cent. of core oil; an increase of 60 per cent. The specific surface of the P.1 sand is about 20 per cent. greater than that of the B sand and it is apparent that the difference in tensile strength is not due simply to the difference in the thickness of the film of core oil on the sand grains consequent on the difference between the two sands.

Tests made with another two silica sands of comparable grading but rather finer than sands B and P.1, the bulk of the sand grains being between 60 and 150 mesh gave results as in Table VI. The respective coefficients of angularity were 1.08 and 1.28 and the specific surfaces 110 and 143 sq. cm. per gm.

TABLE VI.—*Tensile Strength Related to Grain Angularity.*

Bond.	Lb. per sq. in.	
	1.08 angularity.	1.28 angularity.
2.5 per cent. core oil	290	190
2.5 per cent. black core compound plus 0.6 per cent. moisture	100	55

A further difference, which can only be expressed in relative terms, is that providing the mechanical gradings of the silica sands are comparable, the friability of test-pieces in the laboratory or of cores in the foundry is greater for an angular sand than for one composed of rounded grains. A series of sands with nearly identical gradings but with coefficients of angularity of 1.05, 1.10, 1.15, 1.20 and 1.30 was bonded with a mixture of linseed oil and semi-solid core compound, made into A.F.S. test-pieces and baked as usual.

Effect of Grain Shape

After cooling, the test-pieces were compared for surface, friability by rubbing them between the finger and thumb and an increase in friability with increase in angularity coefficient was quite evident.

Numerous other tests were made using both clay and organic bonds, and also mixtures of both of them; all led to the same conclusion that for a given mechanical grading a sand composed of angular grains has inferior moulding properties to one composed of rounded grains and that the differences in behaviour are due primarily to grain shape and the poorer packing properties of the angular sands and not to differences in specific surface. (See also Davies and Rees, Journ. I. and S. Inst., 1944, No. II, pp. 19-46.)

DISCUSSION

Opening the discussion MR. A. TIPPER said Dr. Rees had focussed their attention on the question of grain shape, and he thought rightly so. Sand was a very variable material and anything that would enable them to understand its peculiarities was obviously worth study. He agreed entirely with Dr. Rees' conclusions as regards the effect of grain shape of core sand on the dry strength obtainable with organic binders. They always selected for maximum strength the most uniform grain size and roundness of grain type of sand. He was not so sure, however, that all Dr. Rees' conclusions on moulding sands were equally applicable in practice. Other workers had shown in the past that angular sands in synthetic moulding mixtures would give higher strength than rounded grain sands. Perhaps they could have some information from members on that point. The effect of using old sand should be borne in mind. All the sands, he believed, used by Dr. Rees were new sands. Looking at the results shown in Table III, which compared two sands bonded with Fulbond, one, a highly angular sand, N, and the other the sand, F, of rounded shape, there were one or two strange things that he had noted, on which further information would be welcome. The highly angular sand, N, had a higher permeability than the rounded sand and yet that was contrary to the basis of the method of measuring angularity, a method based on Carman's work on the relationship between permeability and specific surface with degree of porosity of the sand mass. One would expect higher permeability from the rounded grain sand, but the results of Fig. 3 seemed to require some further explanation. It did seem that according to those results permeability was independent of the coefficient of angularity, which, as he had said, appeared illogical.

The question of packing was something which Mr. Sheehan had mathematically explained to them some years ago. But Dr. Rees' remarks about the translation of pressure through a mass of sand were of interest because at the moment most of them who were concerned with sand testing, or methods of measuring the characteristics of sand, were interested in "flowability" and how to measure it. Had Dr. Rees any suggestion, because obviously grain shape did play an important part in flowability. He had mentioned his tube with a load on the top surface, and he would like to know how Dr. Rees measured the depth to which the pressure was transmitted. Was it by measuring the density at different levels? That seemed a method of comparing the flowability of sand.

Going back to his point about the tests being based on new sands, he suggested that the effect of grain shape was not so marked when they were using an old sand which had become coated with clay and the distillation products of coal dust, and such products must obviously affect grain shape. Anyone who examined grains of old moulding sand (floor sand) would see that they lost that beautifully rounded character. All the naturally bonded sands that he had examined had a rather angular grain shape, but this was masked by the bonding material.

Shape and Permeability

DR. REES, in reply, said that for moulding sands as distinct from core sands, one had to modify one's opinions, perhaps dependent on the proportion of bonding material which was present. If a proportion of bond was in the ratio of 20 to 25 per cent., it did mask very considerably the difference due to the actual shape of the sand grain, but where comparatively small proportions of bond were being used in synthetic moulding sands then their experience was that the conclusions which he had indicated did apply quite definitely.

Mr. Tipper's comment with regard to permeability was quite interesting. He thought it was answered quite well by the point to which he drew attention, that with very angular sands there were quite a large number of actual points of contact. The point against that was that the actual permeability could be made higher with an angular sand than with a rounded well-graded sand.

The comments on flowability were interesting. Their conclusions were obtained from the use of a core box with skillets inside the actual core box. They built up a number of ¼-in. skillets and then the sand mix was poured in the standard way, put under the ram after a given time, say three minutes or even less. The whole thing could be easily dissembled and the weight of sand in each of the skillets could be quite reasonably accurately weighed, and the conclusions were very definite in examining all those types of rounded and angular grain sands which were available. He thought it quite possible it might be a pointer to some method of measuring the flowability of sand.

So far as reclaimed sands were concerned they did not confine their work actually to new sands; they examined the behaviour of new sands in various reclamation plants in foundries and they did find that although fine, rounded grain sand did tend to become slightly less rounded after two or three cycles of usage, the angular sand deteriorated from the point of view of shape much faster than did the rounded grain sand. He would not be dogmatic on those conclusions, but they did enough to indicate the likely advantages from a rounded grain sand.

DR. W. C. NEWELL said that there was one aspect of this Paper which had a bearing upon an important

allied subject in which Dr. Rees was also particularly concerned. It was now known that the incidence of silicosis was associated with fine particles smaller than 0.005 mm. in size, and that the particles were probably composed of silica. If particles of such a size were produced from sand grains of normal size, then it would appear necessary that the angular points of such sand grains would have to be broken off, and it was therefore interesting to consider the mechanical conditions which would favour such an erosion of sand grains as distinct from a rupturing operation in which the resultant mean size of the grains would be only moderately less than before the operation. It appeared that the most marked danger appeared in such foundry operations as fettling, in which there was every opportunity to chip off small particles from the sand grains. Whether or not small particles were produced clearly depended upon the magnitude of the impact upon the sand grains. This impact could be relatively severe if it was applied by some other massive body, such as a tool, but it was obviously strictly limited if it arose solely from two sand grains coming into contact, as when airborne or waterborne, and the fact that sands in nature did not appear dangerous might be associated with this fact. Also it might be found that there might be less danger if rounded sand grains were used in foundries instead of angular grains, as there would be thus less opportunity to produce fine angular particles.

Dr. Rees has classified the sands examined in accordance with the roundness or sharpness of the grains, and Dr. Newell said he would like to know whether the differences noted between these two types were consistent with the manner of their occurrence in nature.

DR. REES replied that the wind-blown and coastal sands were generally rounded from the fact of being rubbed together with grain against grain. The angular sands were those which were derived from the break-down of certain types of sandstone or even sandstone which, consolidated, had become ranked as quartzite. Almost invariably sands derived from that type were angular in character. That was the particular differentiation between the two types of sand, but Dr. Newell added the novel and extremely interesting point from the foundry shop point of view, and that was the type of dust which might be produced from the different types of sand. They intended to devote some more time to that, and while the work was not carried far enough to enable one to draw really definite conclusions, there was quite an indication that with angular sand in a knock-out and so on and in other parts of the foundry, more fine dust was produced from the angular sand than from the rounded sand. The fine dust which was produced from the angular sand was measured and much of it was mainly below 0.005 mm. So that although the work had not gone far enough to say that it was a definite conclusion, it was in favour of the rounded sand grain. We had in this country ample sources of sand with a rounded grain, so that we were not of necessity compelled to use the angular sands.

Friability of Sand

A MEMBER said he was very interested in the data which was issued at the present time, but he found it difficult at times to transpose it into usefulness on the foundry floor. They got permeability figures, both bond strengths and so on, and they looked at them and saw one sand was better than another, and still they got moulds badly scabbed. One became a little fogged at times as to where to go for guidance.

He wondered if Dr. Rees or anyone present could give some indication as to which was the best sand, the angular or round, to prevent sand scabs and blows, which occurred at irregular intervals and places

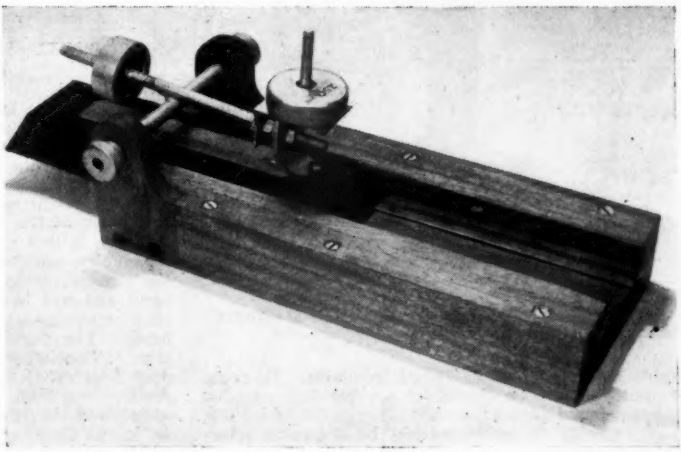

FIG. A. — APPARATUS FOR ASSESSING THE FRIABILITY CHARACTERISTICS OF A SAND.

Effect of Grain Shape

at all times of the day? It was an interesting problem and he had been wondering if sand expansion had anything to do with it and if the round grains were worse than the angular from that point of view.

Then there was the cause of erosion. He noticed Dr. Rees suggested that he could put the sands between his finger and thumb and find one sand more friable than another. He wondered if friability in itself was a bad or good thing. It might be well to have more tests carried out under practical conditions.

DR. REES said the answer to the question was not definitely straightforward. He was not a foundryman, but he did go into foundries a good deal and he had frequently seen an apparent connection between scabbing and the friability of the sand. With a very

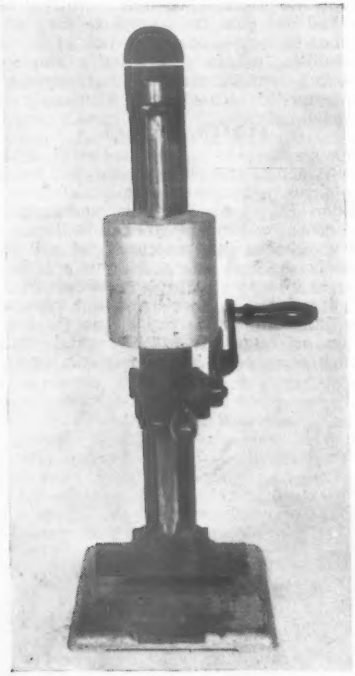

FIG. B.—SHOWS ATTACHMENT TO A.F.S. STANDARD RAMMER.

friable sand scabbing was almost inevitable. He could be quite definite on the difference between rounded grain sand and angular sands with regard to friability. They regarded the rubbing with the fingers as something approaching a practical test. They could not devise a more scientific method with sands at the moment, though he thought it might be done before very long. He thought it more than likely that where scabbing was a trouble it could be traced to the actual friability of the mould or the core, and, as he had said, friability would be decidedly greater with the angular base sand than with the rounded grain sand.

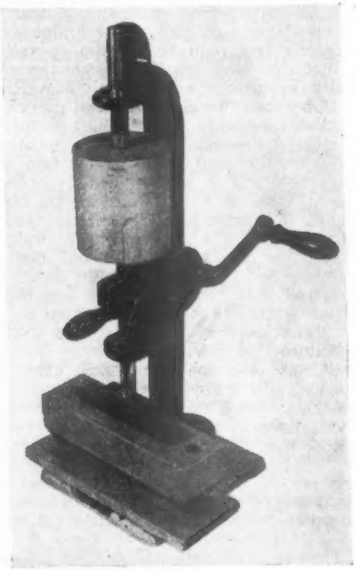

FIG. C.—SHOWS ATTACHMENT TO A.F.S. STANDARD RAMMER.

The CHAIRMAN (Mr. J. J. Sheehan) said he was taking the liberty of answering one angle of the question, that of the usefulness of the scientific information provided to the men on the floor. He thought the correct interpretation of the results by the practical man was much more important than the facts themselves. He knew that a lot of the information provided was very useful, even in that most recent Paper. There were types of angular sand which developed a rather higher tensile strength when used with a clay bond or an oil bond and had been found very useful for the green sand manufacture of air-cooled heads—aluminium heads. The angular sand interlocked, that is, got a grip, and so helped when they were dealing with very deep fins. That was one instance that came to mind. Another was that, if it was a dry-sand mould and they maintained the strength of the sand over 200 lb. per sq. in., he could guarantee they would never get scab-

bing. It could be avoided by the interpretation of the data that scientific facts provided. They could minimise the occurrence of scabbing in a green sand by the admixture of sands. By that they gave an opportunity for some of the expansion to be taken up by the grains that fitted in among the larger grains.

He thought that a Paper interpreting the results obtained by a technical examination of sands was very important and could lead to very good results in the foundry. They probably all realised that about 75 per cent. of the difficulties that arose in a foundry were due to sand and sand conditions. Their metallurgical difficulties were getting less all the time, due to metallurgical control. Sand difficulties were getting less and less frequent, due to sand control.

Core-blowing Practice

A MEMBER, referring to sand core-blowing machines, said the grains he used with that machine were of both grades—it was reclaimed sand—and it was successful. He used four buckets full of reclaimed sand to one bucket of new red sand, and he was quite successful with the cores so blown. The sand which was reclaimed was dried and then mixed through a mixer, and there was no trouble whatever.

DR. REES thought that experience emphasised that they were dealing with a rounded grain sand. The red sand was almost certain to have a rounded grain and it did not easily break up very much, even after quite a few cycles of usage. If they attempted to use a really angular sand in their core-blowing machines, he thought they would be in trouble very soon.

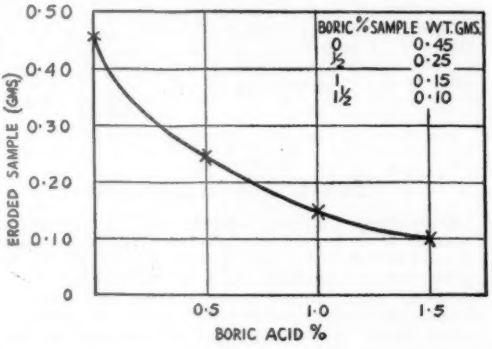

FIG. D.—EFFECT OF VARYING BORIC ACID CONTENTS IN A 4 PER CENT. SULPHUR SAND FOR MAGNESIUM.

Assessment of Friability

MR. D. F. B. TEDDS said the point he wished to make was only indirectly connected to Dr. Rees' Paper and concerned the question of friability. Dr. Rees assessed the friability of his various core mixtures in the usual manner, *i.e.*, rubbing with the thumb and finger. This, he thought all would agree, was not a very scientific method of assessing the friability characteristics of a sand and at Bristol he had evolved a simple piece of apparatus which was open to much improvement, but was at least giving reproducible results and some measure of control.

The tester itself, shown in Fig. A, consisted of a wooden body in which was cut a dovetailed groove to accommodate a metal slider containing the sand specimen. Pivoted over this was a metal arm, one end of which held a metal blade and load platform and the other end a balance weight. The slider was drawn slowly along the body of the tester and the blade scratched the sand specimen. The sand thus removed was collected and weighed and gave a measure of its friability.

The method of producing the sand specimen was controlled since an attachment to the A.F.S. standard rammer had been devised (Figs. B and C). The normal 2-in. dia. disc was replaced with a steel bar 3 in. by 1 in. by ⅛ in. To this was bolted a second bar 6 in. by 1 in. by 1 in. A guide or loading jacket was then fitted over the test-piece slider, the sand introduced (160 gm.) and given six taps on the rammer. The test-piece was now stoved as required and when cool was placed in the tester. Although the original conception of the tester was a limited one, namely, to make comparative tests on core-sand mixtures, it had been used for other interesting work.

Figs. D and E showed the effect of varying boric acid contents in a 4 per cent. sulphur sand for magnesium, and showed a 4 per cent. sulphur + ½ per cent. boric acid sand with varying moisture contents. In conclusion, he added that some form of standardised tester, developed along the lines indicated, seemed desirable for assessing the surface friability of core sands.

A formal expression of thanks from the chairman to Dr. Rees for a very interesting Paper concluded the discussion.

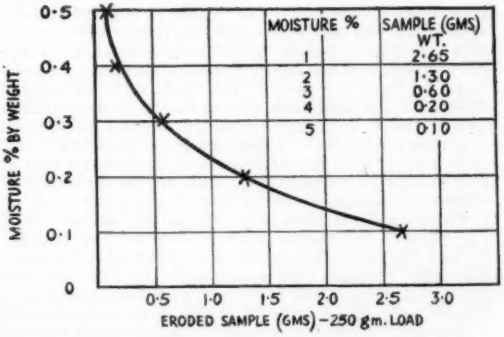

FIG. E.—FOUR PER CENT SULPHUR + ½ PER CENT. BORIC ACID SAND WITH VARYING MOISTURE CONTENTS.

Book Review

Metallic Creep. By A. H. Sully, M.Sc., Ph.D. Published by Butterworths Scientific Publications, Limited, Bell Yard, Temple Bar, London, W.C.2. Price 25s.

In his preface, the author states that he has written this book to appeal to those interested in both the theoretical and practical aspects of creep, and with the objective of helping to bridge the gap between them. This gap—between academic and industrial research—is a very popular subject of discussion, and leads to arguments of such interest that although its importance is usually exaggerated, its existence is quite useful. In the present instance, the subject of creep, it is intriguing to attempt to define the gap by examining Dr. Sully's bridge.

After a concise introductory section, which might usefully have begun its story much earlier than 1905, a chapter is devoted to creep testing technique, providing, in the space available, an excellent survey of the various methods having practical importance at the present time. The meaning of the information obtained from creep tests is then considered under the heading "Characteristics of Creep Curves." "Transient" and "semi-viscous" creep are defined on the basis of Andrade's classical work, and the limitations of short-term tests are emphasised.

At this stage the engineer reader should have a picture of the creep problem, and the metallurgist without experience in this field will have learned how to avoid much waste of effort in gaining it.

The next chapter deals with the nature of metallic deformation processes, comparing and distinguishing the mechanisms of slip deformation and quasi-viscous creep in the light of metallographic research and dislocation theory. This, presumably the main span of the author's bridge, is indeed an intricate structure, and its design would have been easier to follow if economy of words had not been mistaken at times for conciseness of expression. Nevertheless, this chapter provides a summary of present knowledge and views which will be useful to all engaged in research on high-temperature materials. Those on the "practical" side of the gap will welcome in particular the author's plea for greater attention to the phenomenon of tertiary creep, and all high-temperature engineers should learn by heart his words "the onset of tertiary creep represents the initiation of conditions in the material which make it impossible to predict its subsequent creep performance." Those on the "academic" side may ponder over the estimate on p. 121 (and that in the following chapter on p. 140) of the incidence of impurity atoms in so-called "pure" samples.

"Increase," at the top of p. 73, should read "decrease," and the incomplete sentence bridging pp. 82 and 83 is presumably due to a misprint. For completeness "resolved shear stress" (pp. 49 and 66) should be defined and for those who have not seen it before, some explanation of Fig. 76 is surely necessary.

The next chapter deals with "Metallurgical Factors Affecting Creep" and metallurgists may reasonably complain that its 24 pages are scarcely adequate to cover the very considerable body of knowledge and experience which is now available. This space is disproportionate when compared with the 65 pages of the preceding chapter. It may perhaps be claimed that the balance is redressed by the chapters which follow, describing the creep properties of steels and cast iron, tin, lead, zinc, magnesium, aluminium, copper, cobalt and their alloys. These could not hope to be comprehensive and their usefulness in the author's context is dubious. They are not written to illustrate the theme of the preceding chapter and, as guides to useful materials, they have too many gaps. In a subsequent edition of the book, these chapters might profitably be replaced by a more thorough consideration of the metallurgical aspects of creep, a consideration which cannot be complete without some reference to the findings of Bennek and Bandel ("Stahl u. Eisen," 1944). The effects of strain history need fuller treatment, and available information on precipitation-hardening phenomena can provide a more thoughtful dissertation than the author has given. Such a modification would lead more logically than does the present text to the final chapter on the "Development of Creep Resistant Materials," in which a surprising omission is a serious consideration of the relative merits of casting, forging and powder metallurgy as methods for producing the creep-resisting alloys of the future.

The gap which Dr. Sully has attempted to bridge remains undefined. This is perhaps due in part to the probability that no creep research has yet been carried out on materials of purity high enough to ensure that impurities have not had an important influence on the effects or results found, and in part to the difference in outlook between those who want to know how materials flow and those who do not want them to flow. In his foreword to the book, Dr. Allen describes it as both timely and welcome. All who are concerned with high-temperature engineering materials will find this description to be apt.

H. W. G. H.

New Catalogues

Aluminium Marine Alloys.—T.I. Aluminium, Limited, of The Adelphi, London, W.C.2, have just released an attractive eight-page leaflet setting out the application of aluminium alloys in marine engineering. Good use of colour has been made and one can almost smell ozone while perusing it. Although, of course, Tube Investments is well known, the reviewer still thinks an address should have been incorporated somewhere.

Factory Painting. A brochure received from Pilchers, Limited, 6, Chesterfield Gardens, Curzon Street, London, W.1, covering this new and interesting field is in every way excellent. The printing and examples given are of such a character that they are bound to interest the modern-minded foundry executive. The reviewer suggests to his readers that they should write to Curzon Street forthwith for a copy.

The Pattern Shop*

By S. Jane.

Organisation

This is the first point on which there are usually differences of opinion. Dealing first with the average shop of, say, five journeymen, with two, or perhaps three, apprentices. Under these conditions the foreman's duties (he is included in the five journeymen) would include controlling the shop and checking patterns, and he would be able to fit in a certain amount of bench work.

The shop itself could be comfortably fitted into a floor area of 30 by 40 ft. It would be almost impossible to design a pattern shop with too many windows, while the doors should be sited to make the most use of the machinery. In a shop of this size one would expect to find machinery of the following description:—A 24-in. and a 14-in. band saw; a 30-in. disc and bobbin sander combination; a wood lathe and 12-in. by 14½-in. thicknesser. These machines must be sited conveniently to the work benches, otherwise time will be lost by men walking to and fro. It will be noticed that a circular saw bench has not been included in the layout, the reason for this omission being that it is felt that the circular saw is a very dangerous machine, and should be only used by one man in any shop; therefore, it does not suit a shop of this size.

The following procedure is taken when a "works order" is sent to the pattern shop with its drawing. If it be an every-day type of job, the foreman will decide the method of moulding and the making of the pattern. Where a particular job is out of the ordinary, he would call in the works manager, with the foreman moulder, to discuss the best way of moulding and the positioning of heads and runners. These points having been cleared up, he will make out a pattern card and, with the drawing, will give the job to a pattern-maker. He will pass on the instructions for the method of moulding, and possibly touch on the method of making the pattern; however, this is best left to the man concerned, except where he asks for an opinion.

Right Job for Right Man

At this juncture a foreman should use his judgment in giving the job to the right man. Some hold the view that any job should be given to any journeyman, on the principle that, because he has served his apprenticeship, he should be as capable as the next man. The Author does not subscribe to this viewpoint. Some men have the happy knack of seeing short cuts in what appears to be an intricate piece of work, while others, not so blessed, more than hold their own on the general type of work.

From time to time articles have appeared on the training of apprentices, but in the average size shop such as that under discussion it is difficult to lay down hard and fast rules. Conditions alter from week to week, and the training of apprentices must vary accordingly.

Leaving the small shop now to touch on a shop of, say, thrice the size, the general procedure would be similar to the smaller counterpart, with one or two exceptions. Here it is found that the foreman's time would be taken up more on the executive side, and he would have "charge-hands" to assist in the running of the shop. To work a shop of this size efficiently would require consirably more machinery than the smaller shop, and the following is suggested:—Two 14-in. bands and two 18-in. sanding discs convenient to the benches, a 36-in. band saw, circular-saw bench, double disc and double bobbins, 24-in. thicknesser planer, centre and faceplate lathes. A pattern miller would be an asset.

In such a shop a joiner-machinist should be employed to operate the circular saw and planer, timber being bought in bulk and thicknessed to the requirements of each job. The Author is not rash enough to pass any opinions on shops employing 30 or more pattern-makers.

Materials

Of the many various materials used in pattern-making, timber, of course, is the most common. Clear or yellow pine is the most suitable timber for the general run of pattern-making, while hard woods, such as teak, are used in cases where patterns have to stand up to hard work. It is not proposed to delve deeply into consideration of timber, but rather into other materials. Aluminium is perhaps the most suitable metal for pattern-making, because of its lightness and ease of working; the chief disadvantage is the difficulty in casting this metal without draws taking place. It is also claimed by some foundrymen that there is a tendency for an aluminium pattern to strip badly when cold; however, this is a rather contentious point. Brass is another useful metal in the pattern shop. It is fairly easy to work, leaves a polished surface. can be soldered easily, but is rather on the heavy side.

White metal, due to its low melting point, is another metal which has many applications in pattern-making. The most useful metal for small patterns so far used is a bismuth-alloyed metal, which could be melted in boiling water. The price of this metal has now made it an uneconomical proposition for pattern-making. Under miscellaneous, there are such items as beeswax. Due to the new core and moulding sands used to-day, beeswax has its limitations. A few years ago it was used extensively for filling holes and filleting, but new sands have a very destructive action on this "pattern-maker's brains." It is successfully replaced by certain paint fillers and plastic woods.

Leather fillets are very useful in some cases, but after a while the leather seems to harden and the ends tend to curl. It is here that one day the "plastic

*A Paper read before the South African Branch of the Institute of British Foundrymen, Mr. H. Teubes presiding.

The Pattern Shop

industry" will come to the pattern-maker's aid with plastic fillets. It would be a godsend if they could include the adhesive in much the same way as the motor tube patching of to-day. There are further items where plastic manufacturers could help us, such as with standard core prints, alphabetic lettering, etc.

Before leaving the subject of materials, mention should be made of a material similar to plaster-of-Paris. This material dries extremely hard and is very durable. An original order for a sheave was for one only, and, therefore, a pair of strickles were made; a repeat order came later for a dozen sheaves. A mould was made in the usual way, and a light wire frame was placed in the mould to reinforce the plaster, which was cast into it. The sand was brushed off this pattern, and since then many dozens of moulds have been made from it. Shellac varnish is still used; there appears to be no better substitute for this varnish. Its lustre can be improved by small additions of oxalic acid.

Pattern Storing

There are many different ideas on how pattterns should be stored. All are agreed that the store itself should be fireproof; in other words, built of brick with steel or concrete shelves. It should also be large, well lit and properly ventilated. Having all these characteristics, the main problem still has to be solved, namely, to store patterns so that they can easily be found when required.

Comparing two of the many systems used in pattern storing, first there is group storing and then the index-card system. By group storing is meant that patterns made for the various customers are stored in customer groups in the store shelves. In other words, A's patterns are allocated a shelf or shelves and are kept together, while B's and C's are treated likewise. The patterns are given numbers, which are stamped on to each part and the core boxes. The numbers are entered into a register against the customer's name, with a short description of the nature of the pattern.

This method, while it is a popular system of pattern storing, has quite a number of disadvantages. First, before long it is found that A has become a prosperous industry, and soon they have many scores of patterns, which, in turn, require many shelves. B and C, who are not doing so well, or perhaps have standardised on a few lines, only have a few patterns. One is then inclined to allow D to share B and C's shelves; consequently it is not long before there is a certain amount of confusion.

Further, one is never too sure in which of A's many shelves one must look to find a particular pattern that he may be wanting. There is often a doubt as to whether the pattern is in the store or the foundry; have all the loose pieces and core boxes been returned? Finally, after a few years the register leaves have become loose, and a search is instituted for the relative page before a search for the pattern can begin.

With the index-card system, every pattern is given a card, as shown in Tables I and II. On this card there is the customer's name and drawing number, the pattern and shelf numbers, the weight of the casting, and a short description of the pattern. Below these headings the card is ruled off vertically into four divisions under the sub-headings: date, job number, foundry, and store. To appreciate how this system works, it will be advisable to describe the procedure from the time when a works' order and drawing are sent to the pattern shop. The foreman will fill in a pattern card under the headings: customer, drawing number, pattern and shelf number. Under "description" he will mention the number of patterns and core boxes. In the first line of the sub-heading he will write the date and the name of the pattern-maker to whom the job is given; in the next line, under job number, he will quote the works' order number.

TABLE I.—*Index Card for a Pattern.*

WORKS (PTY.), LTD.

Firm—A (95)
Drg. No.—B 36 Weight.—210 lb.
Patt. No.—1257 Shelf.—13-C
Remarks.—Bedplate 15 in. hoist
1. Pattern. 3. Core boxes.
2. Loose bosses.

Date.	Job No.	Foundry.	Store.
17.5.47	J. Koos	*x'* who	
13.5.47	197	24.5.47	30.6.47
31.8.47	315	2.9.47	3.10.47
4.11.47	402	7.11.47	—
12.11.47	409	—	

TABLE II.—*Reverse Side of Pattern Index Card.*

Timber.	Time.
10 ft. × 12 in. × ⅞ in. 3 ft. × 12 in. × 1½ in. 7 ft. × 12 in. × 2 in.	22½ hours.

30.6.47
1 loose boss missing.
2.9.47
New boss made.
7.11.47 Job 402.
3 in. core reduced to 2½ in.
A's instructions.

The card, with its drawing, is then passed on to the pattern-maker, who can see at a glance what is required, and has the information for filling in his time sheets. On the reverse side of the card, which is blank, he will fill in the time taken on the job; also the materials used. It can be seen that this information is most useful for reference when quoting on further work. When the pattern is completed, the card is returned to the foreman with the drawing. Whoever checks the pattern, also signs the card alongside the maker's name. The pattern is now sent to the foundry, and the date is written on the card under the sub-heading "foundry." This card is now placed in the filing cabinet in its customer group, these groups being kept in alphabetical order. Each card is given a number in the top right-hand corner, so that it can be seen instantly should one card be missing from its group.

Leaving the cards for a moment to look at the store itself, here it is we find that the shelves divided into compartments about six feet in length. The patterns are not in customer groups, but mixed together, the number of patterns per shelf being controlled by their size. The shelves are numbered, the first bottom tier being 1A, the second 1B, and so on.

When a pattern is returned from the foundry to the stores, the date is entered on to the pattern card under the sub-heading "store." On occasions patterns are returned from the foundry with bosses or parts missing. These patterns are not stored until a thorough search has been made for the missing pieces. If they are not found, a pencil note is made on the back of the card to that effect, the pattern being then stored in the usual way. Should the offending part turn up at a later date, the pencil note is erased.

It can be seen now that if firm A asks for a repeat of its bedplate, by turning up the particular card, there is all the necessary information. It can be seen at once whether the pattern is in shelf 13C or if it is in the foundry. It is also known if the pattern is complete or if there are any parts missing. One can tell the moulding shop when it was last made and also the weight of the casting. Cards for standard patterns, such as gears, sheaves, wheels, etc., are usually kept under those headings instead of under "customer names." Where one pattern serves two or three customers, cards are made out for all the customers, a note being made on the cards to this effect.

Under pattern storing, there must be included storing in the foundry whilst the order is being executed. This is a most vexing problem and, until every moulder can see the value of a pattern in hard cash, no solution is in sight. An arrangement which has been tried out with little or no success on several occasions, due mainly to the lack of co-operation from the moulders, is as follows:—

An area in the foundry was set aside where three sets of shelves were built and marked "incoming," in-use" and "completed." Patterns sent from the pattern shop were placed on the "incoming" shelf. When the job was allocated, it became the moulder's responsibility to return the pattern to the "in-use" shelf, complete with prints and loose pieces at the end of each shift, core boxes remaining at the core bench until the order was completed. The Author makes the point of returning loose pieces, etc., to the shelf with the pattern, because it has often happened that a conscientious moulder has placed such pieces in his tool box for safe keeping, and then, through some unforeseen circumstances, he has not been able to come to work, with the result that the pattern has had to remain idle. When the order is completed, the moulder will collect the core boxes, check the pattern to see that it is complete, and place it on the "completed" shelf. At a convenient time all the patterns on this shelf are returned to the pattern shop and then to the store.

This system is simplicity itself; yet it does not seem to function very well. Maybe pattern-makers cannot see pattern storing from a foundry point of view, but pattern-makers are always open to suggestions.

Conclusion

The pattern shop in any foundry is the focal point where the managerial and foundry interest meet. At one time it was considered a necessary evil, but to-day the pattern shop finds itself being raised to its correct status in all foundries. On the efficiency and accuracy of the pattern shop, the standard of the castings produced in the foundry depends. A good true casting cannot be produced from a bad pattern, and, inversely, there is no excuse for a bad casting from a good pattern.

DISCUSSION

MR. FUTTER, proposing a vote of thanks, said he was particularly interested in circular saws, especially from the safety aspect. He also asked for Mr. Jane's views on the problem of dust extraction. Who was in charge of pattern storing and the checking of cards?

MR. JANE replied that he considered the circular saw the most dangerous machine in the pattern shop. It was built with guards and fences that rendered it practically harmless, but there were few shops where these remained in place after the machine had been in use for several months. Unless it was handled by one man only, he considered that it presented a constant hazard. Dust extraction was very difficult to carry out properly in a pattern shop. On discs, the dust could be very effectively controlled, but on bobbins 100 per cent. control could never be obtained. Band saws were connected up with the extraction system, but the dust never seemed to be very effectively controlled. In most instances where the index and card system of returning patterns to store was in force, it was usually in the charge of a senior apprentice, who was also responsible under the foreman's directions for the selection of the pattern from the store. In larger firms, where a storeman was in charge, the system was completely successful. The storeman not only did the checking, but also carried out minor repairs and put the pattern back in first-class condition.

MR. ZWANZIGER, seconding, said, so far as he knew, only one firm in South Africa had adopted the planning system. He had had some experience of this system and believed that it could very usefully be introduced into South Africa. In South Africa, layouts of pattern shops were usually done in half an hour, but in some overseas firms they were worked out completely in the office. The question of machinery was very important. Every shop should have a circular saw, which must be of the right type. Setting up of machinery in the shop was important, and in planning the layout of machines, the exact sequence of operations should be taken into account. Mr. Zwanziger's objection to setting the benches along the wall was that the pattern-makers did not like to work with their faces to the wall and their backs to the shop. On the Continent and in the East they put the benches a few feet away from and at right angles to the wall, so that there was plenty of light on the benches when the men were

The Pattern Shop

working. The benches were of the German type with front and rear vice.

Criticising the practice of putting the office in a dark corner of the shop, Mr. Zwanziger expressed the opinion that for a big shop the office should be located near the door and there should be a barrier to provide a check on parts being carried away without authorisation. On the subject of materials, he pointed out that in the Northern countries very cheap and good pine timber was obtainable. In South Africa various types of pines were imported, but nowadays they were only available in very limited quantities. Most men in the shop were not interested in the enormous amount of money involved in timber. Pieces were apt to be cut a couple of inches too long and it was often too much trouble to delve into the stack for a short piece required. He mentioned these points because he had been in so many countries and pattern shops. In the East only teak was used. There should always be a plentiful supply of nails, screws, etc., in the cupboard, and the foreman should keep a check on them. Storing patterns was a big item. There must be many hundreds of thousands of pounds worth of patterns in store. Usually they were left in charge of a few natives, some of whom were quite efficient. Personally, he believed in storing patterns according to types rather than customers.

MR. JANE, replying to Mr. Zwanziger, said that in a large shop he did favour installing the benches in the middle of the shop, but in the smaller firms the pattern shops used to be housed in some entirely inadequate building near the foundry. In a shop, say, 30 ft. by 40 ft., he thought it was better to have the benches round the wall in order to save space. He agreed that the pattern-makers did not like looking at the wall. In their present shop the benches were so arranged that every man had a window to look out of. Timber, regarded from the point of view of off-cuts, was a very valuable material and after sawing should be segregated into two separate compartments, namely, useful timber and scrap. That was left entirely in the foreman's hands. In his view, the shorter off-cuts should be got rid of as soon as possible because it was surprising how quickly the waste accumulated.

MR. FENTON was surprised that Mr. Jane preferred a small thicknesser to a large one. A 30-in. machine was not used for putting small pieces through. He was also surprised that Mr. Jane did not favour the combination thicknesser surfacer, which saved considerable time with the timber at present being used.

MR. JANE pointed out that in a small shop timber was usually purchased cut and planed and thickened to the standard thickness. Their thicknesser was used only for thicknessing from standard to special thicknesses. The biggest drawback to the thickness surface was that in a small shop it took up too much space.

MR. HOLDSWORTH urged that pattern-makers should give foundrymen facilities for rapping and loosening and drawing straps which would eliminate the risk of damaging patterns. Information as to the use for which the finished product was intended should be given to the pattern-maker and moulder jointly. That was the deciding point as to how the job should be made. He suggested that colouring patterns to indicate the machined and as-cast surfaces,* etc., would enable the moulder or the man in charge of the foundry to know what had to be done and how the job should be cast to give the best results.

MR. JANE, agreeing, said rapping plates should be put into patterns, but in a thin pattern—with plates, say, ¼ in. thick, he would prefer to place the blocks only on the edge of the pattern, as he considered that rapping on the side instead of the centre would be less dangerous to the pattern. From his experience in steelfoundries, it was surprising to find which way a job should be cast to give the best results. Jobs which for several years had been cast one way up gave better results when reversed. Mr. Holdsworth's suggestion of colouring a pattern was most constructive. Every pattern should be marked clearly to show the machined and as-cast surfaces.

MR. ZWANZIGER pointed out that, *inter alia*, the American Foundrymen's Society had issued a sheet of colours for indicating rough machining, fine machining, etc. He thought the price of paint might be the reason why this system was not in general use. Part of the drawing office should be allocated to planning and representatives of the foundry and pattern shop with a good knowledge of drawings should be given a place there. Much time was wasted in a shop because the foreman had not time to look at the job immediately. He would give the drawing to the men in the shop to study and might then be called away and have to decide in a few minutes how the job should be done. Before the war, the Institute in South Africa went into the question and found that 71 per cent. of the drawings used in the shops were not correct. A properly-staffed planning office would save considerable time. More time should be allowed to the foreman to discuss the job, because this saved time in the end.

Colour Scheme for Patterns

MR. JANE said that a colour specification was an interesting point. He believed that to some extent every foundry farmed-out patterns. On very few occasions did his company receive a pattern from an outside firm on which the machining was clearly marked.

MR. GOYNS said that the foundry technical institutes had published comprehensive information on the subject of pattern colours, and excellent charts were available. The standard colours were red for core prints, black for black faces, yellow for machined faces, cross hatched for loose-piece locations, and so on. On the subject of planning, he thought that the tendency that evening had been to overstress the planning which took place at too late a stage—so late a stage sometimes that it was difficult to see where production began and planning ended.

*This is covered by a British Standard Specification.—EDITOR.

They were apt to forget that they planned to a greater or lesser degree, when quoting for a job. In order to quote accurately it was obvious that a plan of how the casting was going to be made should be clearly defined in the minds, at least, of the individuals concerned. Herein Mr. Holdsworth's remarks were germane. The pattern-maker's knowledge of gating and feeding was often very elementary and he was perhaps apt to forget that the best way of making the pattern from his viewpoint was a secondary consideration to the other factors involved. In his opinion, in planning and method control, the chief factors were, in order of importance: first, the production of a sound casting; second, ease of moulding, especially of a quantity job; and, third (a factor which frequently arose in South Africa), whatever method employed must fit in with existing tackle and box parts. Regarding planning in the actual pattern shop, he believed that not many firms overseas had reached the stage of deciding when planning, the amount of timber required for each pattern. Most firms were more concerned with the moulding method, the time the job was going to take and the probable effect on the shop load as regards delivery.

There was one little machine which Mr. Jane had not mentioned—the bench planer. This was a very handy little machine and, where benches were end to end, could be inserted very conveniently in the bench between two men.

Altered Patterns

MR. HOLDSWORTH, referring to the tabulation of patterns which had been altered to suit the requirements of different customers, asked under which customer the pattern should be indexed—the original customer or the one for whom it had been altered.

MR. JANE explained that the alterations and the date on which they were made were noted on the back of the card, so that a full record was always available from the card. The position in which the pattern was stored would depend on which customer was likely to need it first. The job would be given two cards made out in duplicate, one for each customer. The racks, however, would not be for either customer, since—as he had explained in his Paper—they were progressively filled throughout the store.

Overseas Planning

MR. ZWANZIGER said that another kind of planning adopted overseas consisted in making a list of all timber required down to the smallest pieces after the drawing had been prepared. Then all the timber was cut up and planed, the pattern-maker being provided with a rack about 6 ft. high next to his bench in which to keep it. This planning was done by the pattern-maker, so that he did not become an operator as was mentioned at the meeting. Some firms overseas went still further and supplied complete drawings of how to build the pattern up.

MR. JANE said that that was exactly what he was getting at. The amount of material required for each individual job should be given to the joiner, from whom it should be despatched to the pattern-maker who would receive it with his drawing. All the pattern-maker had then to do was to mark out his timber and get on with the job.

MR. GOYNS suggested that if the pattern-maker was handed his timber cut ready for the job, the human element would be one of the principal problems, apart from the fact that most men varied in their methods. When dealing with large castings, if a man was given a large assortment of bits and pieces, he could foresee difficulties arising.

Personal

SIR OTTO E. NIEMEYER has been elected a director of the International Nickel Company of Canada, Limited.

MR. V. A. PATTERSON has been appointed deputy chairman and managing director of J. & E. Hall, Limited, engineers and ironfounders, etc., of Dartford, Kent.

MR. H. J. BULLOCK, of the British Moulding Machine Company, Limited, who recently returned to this country from Spain and Portugal, is leaving on September 30 for a business visit to Czechoslovakia, Poland and Hungary.

MR. A. W. GREGG, a director of the Whiting Corporation, Harvey, Ill., is to spend a few days in this country. He presented the official American Paper to the International Foundry Congress at Amsterdam and since then has spent some time in Belgium and France.

MR. H. STEWART CRAIG has retired from his position as managing director of the Llanelly Steel Company (1907), Limited, and has been appointed chairman in succession to MR. T. BYNG MORRIS, who has resigned the chairmanship owing to ill-health. MR. H. W. PYLE has been appointed managing director.

MR. DONALD M. BROWN, commercial manager of Keith Blackman, Limited, was last week presented with a grandfather clock, to mark the completion of 50 years' service with the company. Mr. Brown started as an office boy with the original Blackman Ventilating Company, Limited, just before its amalgamation in 1900 with James Keith, manufacturer of boilers, radiators, etc. In 1938 he was given a seat on the board.

Wills

TAYLOR, B. C., partner in Taylor Bros., brassfounders, etc., of Small Heath, Birmingham £15,371

JOWETT, WILLIAM, of London, S.W.1, who formerly had large steel interests in Sheffield, Glasgow, and London £119,330

MOND, HENRY LUDWIG (LORD MELCHETT), formerly deputy chairman of Imperial Chemical Industries, Limited, a director of the International Nickel Company of Canada, Limited, the Mond Nickel Company, Limited, Ashmore, Benson, Pease & Company, Limited, Power-Gas Corporation, Limited, and other companies, and deputy chairman of the South Staffordshire Mond Gas Company £96,968

Floating Cores

By "Tramp"

Although the majority of cores assembled in a mould are positioned by means of core prints, cases arise where these can be dispensed with and the core "floated" in position. Such a case is illustrated in Fig. 1, being a gear box cover. The writer has seen

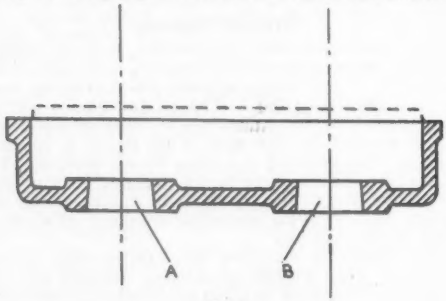

FIG. 1

various patterns for this cover made in different ways. The most usual pattern encountered is that with a core print dowelled on to the back, as dotted lines, into which the core is placed and wired into position to prevent it falling out on assembly.

The next variety makes use of what is termed the "mushroom" type print, as Fig. 2. The advantage

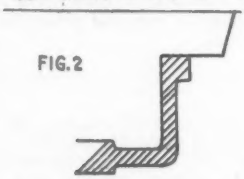

FIG. 2

of this print is that the core is placed in the bottom half and if thought fit a top box could be dispensed with entirely. One disadvantage of both methods, however, is that the moulder has no means of checking the metal thickness around the walls of the casting.

By eliminating the print entirely and making the core so that it can be placed in the mould on the two pods of sand—left by the pattern as A and B, Fig. 1—of the correct thickness, the metal thickness around the sides can be checked by means of thickness strips. By this method, the core is just positioned and the top placed on, no need for wiring the core to the top being necessary for the pods take the weight of the core when assembled; as soon as the metal enters the mould the core is pressed tight against the top by reason of the difference in density of the core and the metal. Thus it is that the core is said to be "floated" in position.

Institute of Vitreous Enamellers

Annual Conference Programme

The 15th Annual Conference of the Institute of Vitreous Enamellers is being held at the Grand Hotel, Birmingham, from October 6 to 8. Below, we give the programme in detail:—

Thursday, October 6.—9.30 a.m., annual general meeting; 10.30 a.m., "Factors Affecting the Colour of Titanium Enamels," by N. F. Miller; 12.45 p.m., lunch; 1.45 p.m., depart for visit to J. A. Jordan & Sons, Limited, Bilston; 7 p.m., theatre party.

Friday, October 7.—9.30 a.m., "Cast Iron for Vitreous Enamelling," by H. McNair; 11.15 a.m., "Furnace Atmospheres in Vitreous Enamelling," by S. E. A. Ryder; 1 p.m., lunch; 2 p.m., depart for visit to W. & T. Avery, Limited, Birmingham; 7 p.m., reception; 7.30 p.m., dinner and dance.

Saturday, October 8.—10.30 a.m., demonstrations of the following new testing apparatus:—(*a*) Albright reflection meter; (*b*) Albright gloss meter; (*c*) Nash & Thompson's colour comparator, and (*d*) G.E.C. layer thickness meter; discussion of "Question Box" queries; 1 p.m., lunch.

The programme includes lectures on technical and practical problems, presented by well-known technicians, which give ample opportunity for free discussion. The works visits will give a practical demonstration of vitreous enamelling, and from these visits much can be learned. In these days of competition and production difficulties, many special problems arise; it is for these that a question box is to be provided at each lecture. All questions are anonymous, and replies by selected technicians will be given.

I.B.F. Golf Meeting

At the annual I.B.F. Golf Competition, which this year is to be held on September 24 and 25 at Woodhall Spa, Lincolnshire, a four-ball challenge match has been arranged between the Institute and members of the Lancashire Transport Association. On Saturday night I.B.F. members are invited to a dance organised by the Transport Association at the Petwood Hotel. In addition to the I.B.F. Handicap Challenge Cup, the new I.B.F. Scratch Challenge Cup (presented by the Lincolnshire Branch) will be competed for.

New Draft Standard

A new draft standard for heating stoves has been prepared by technical committee SFE/13, "domestic solid-fuel appliances," and, in accordance with the customary procedure of the British Standards Institution, is now being circulated for technical comment. It should not yet, therefore, be regarded or used as a British Standard. The committee would very much appreciate the views of interested parties on this draft specification before Friday, October 28.

Mechanical Properties of Some Copper-base Alloy Castings

This Report was presented on behalf of the Technical Committee of the Association of Bronze and Brass Founders by its chairman, Mr. F. C. Evans, to the Annual Meeting of the Institute of British Foundrymen, held at Cheltenham earlier this year. The Report was published in the JOURNAL *for July* 7, 14 *and* 21.

MR. V. C. FAULKNER, Past-President, who took the chair, described the Report as one of very special character because, for the first time in the history of the Institute, they had a Paper from one of the manufacturers' associations and it was very pleasing to see what a co-operative effort of this character could produce. He had not known that he was to have the privilege of presiding, so he had no remarks prepared. He thought, therefore, that they would prefer to hear what Mr. Evans, who had presided over the Committee, had to say than to listen to any further remarks from the chair.

Reason for the Report

In his introduction, MR. F. C. EVANS said that the Report was written because during the war there was a series of failures of bronze and brass castings on various types of equipment, such as tanks, guns, etc. The result of these failures was extremely serious and to overcome them the appropriate inspecting authority, the Inspectorate of Fighting Vehicles, began to impose acceptance tests on castings which involved the cutting of test-bars from the actual casting itself. It was soon learned that acceptance of a batch of castings depended on obtaining the specification figures for the test-bar cut from the casting.

That brought difficulties and many members appealed to the Association for action. A Conference was called between the Inspectorate and the Association of Bronze and Brass Founders, from which there came a new code of procedure which was acceptable to the foundry industry. The conference also showed that designers expected to have the specification strength in each and every part of the casting. The new code of inspection recognised that this was not possible in all cases and could only be obtained if specially called for. From this code of procedure the work was taken up by the B.S.I., and in 1947 a Code of Procedure in Inspection of Copper-base Alloy Sand Castings (B.S.S. 1367) was issued. The Association of Bronze and Brass Founders was also represented on the committee which formulated this procedure and did much to see that the Code was workable and acceptable.

All the work of these two committees made it abundantly clear to the Technical Committee of the A.B.B.F. that very little, if any, knowledge existed regarding the mechanical properties to be expected in a casting. It was, therefore, decided that, with the co-operation of various member firms, some research should be made into the properties of the different types of copper-base alloy castings. It was decided to collect as much data as possible relating to the production of the castings as well as the actual mechanical tests themselves, and it was those results which the Committee presented in the Report, hoping it would stimulate further work in this field. It could not fail to be of great use both to designers and founders.

Important Conclusion

One of the important conclusions reached in the Report was that a casting, to be serviceable, need not yield mechanical test figures to specification, a good example being gunmetal valve bodies which, while satisfactory on pressure test, commonly gave mechanical test results well below specification.

Aluminium bronzes and hyper-tensile bronzes, on the other hand, seemed quite capable of giving results in the casting which were well up to specification figures, providing the casting was well fed.

In general terms it could be said that alloys with high shrinkage characteristics, that was alloys with a short freezing range, gave good mechanical properties within the casting itself, while alloys with a long freezing range tended to give results which were below the specification figures. This latter class of alloys, which included the gunmetals and bronzes, suffered much from interdendritic porosity, which could be due either to gas unsoundness or unfed shrinkage cavities. Those cavities were, of course, in part responsible for the lower properties obtained.

The Report was somewhat limited in the range of alloys tested, as the Committee was cursed—or blessed—in the copper-base foundry alloys with a very wide range of alloys with widely differing foundry characteristics. Notable omissions in the alloys tested were the ordinary brasses and any of the silicon-containing alloys. He hoped that, if any members present had had experience of those alloys, they would take part in the discussion, as his Committee would be very interested to hear what they had to say.

DISCUSSION

The CHAIRMAN said that the meeting was now open for discussion and the reminder had been given them that information on similar conditions governing the process would be welcomed.

MR. FRANK HUDSON said that he was particularly anxious to open the discussion because, as many of them knew, he represented the Institute of British Foundrymen on the Technical Committee of the Association of Bronze and Brass Founders. The data given in the

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Report were bound to be of great value both to the founder of copper-base alloy castings and the engineer who used such products. Information of that nature would assist the founder in his endeavour to produce castings of highest quality and would provide the engineer with reliable data for design purposes. Furthermore, it was particularly gratifying to have a contribution of that kind, as it denoted intimate co-operation between the Institute and the Technical Committee of the Association of Bronze and Brass Founders.

Before commenting on the Report he would, therefore, like to take that opportunity of saying how much they all appreciated that gesture. In the conclusions arrived at by the A.B.B.F., it would be noted that a good many more tests had still to be carried out before the preliminary work was completed, and he would suggest that if they valued this co-operation, they now had the opportunity to provide tangible assistance either by doing tests on their own castings or by disclosing information if such tests had already been done.

During the war he had assisted many of the Service departments in connection with the properties of copper-base alloy castings, and some of the information then obtained might form a useful contribution to the discussion. He did not know of any other instance where foundrymen had set out to show what were the actual properties of their castings. More often than not they did not want to say anything about them. The Technical Committee of the Association of Bronze and Brass Founders was to be complimented on its foresight in starting investigations in this direction, and he sincerely hoped that the work would go on.

At the conclusion of his remarks, Mr. Hudson submitted Tables A, B and C and Figs. A to D, which are shown herewith.

Table A, he said, outlined the properties of 85/5/5/5 and 83/7/5/5 gunmetal test-bars and their relation to small pipe castings (having dimensions as shown in Fig. A) which had to withstand pressure.

These tests, Mr. Hudson said, differed from those done by the A.B.B.F., which were based on test-bars cut from the castings, because the castings were actually tested to destruction and invariably failed (as illustrated in Fig. B).

Effect of Section

It was interesting to note that, apart from there being no relation between the properties of the test-bar and the casting, failure occurred in the thinnest section of the casting which undoubtedly had the highest mechanical properties. It was, therefore, most important, when evaluating casting quality from test-bars cut from the casting, to take into account the effect of section as well.

The conclusion that castings in alloys with a short freezing range, such as aluminium bronze and high tensile brass, could be made completely sound and with properties equal to those of separately-cast test-bars with similar cross-section, provided the metal was not gassy and the castings were properly fed, was most interesting and was confirmed by his own experience.

Table B indicated the properties of test-bars cut from small aluminium-bronze propeller castings in relation to separately-cast bars. It would be observed that the properties of the castings were equal to, or better than, the separately-cast bars, which themselves provided a reasonable margin over the requirements laid down in B.S. 1400-AB2-C. The propeller castings in question were cast in dry sand in the manner shown in Fig. C, using a light chill in the top part of the mould at the blade root to eliminate shrinkage cavities liable to occur at this point.

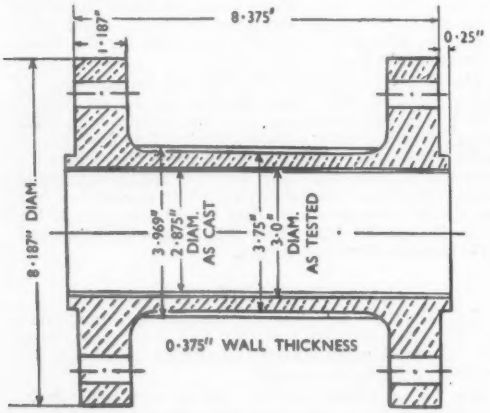

FIG. A.—DIMENSIONS OF 85/5/5/5 AND 83/7/5/5 GUNMETAL PIPE CASTINGS USED FOR PRESSURE TESTS.

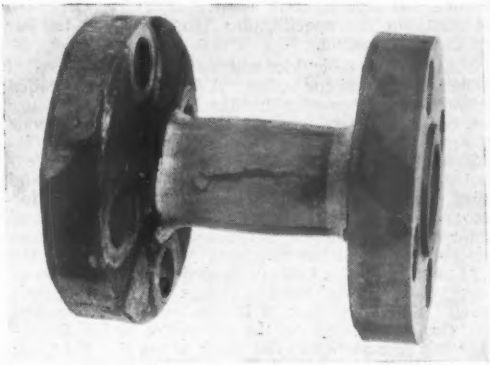

FIG. B.—APPEARANCE OF 85/5/5/5 AND 83/7/5/5 GUNMETAL PIPE CASTINGS AFTER TESTING TO DESTRUCTION.

TABLE A.—*Properties of 85/7/5/ and 83/5/5/5 Gunmetal Test-bars and Related Pipe Castings (see Fig. A).*

Type of casting.	Composition, per cent.						Pouring temp., deg. C.	Properties of cast test-bars.[1]			Bursting tests on castings, Lb. per sq. in.
	Cu.	Sn.	Pb.	Zn.	Ni.	P.		M.S., tons per sq. in.	E., per cent. on 2 in.	Type of test-bar.	
85/5/5/5 *Gunmetal* .. .. Double-flanged pipe. (Cast by firm A, 12/2/1945.)	84.64	5.25	5.47	3.97	0.67	Trace	1,140	17.2	52.0	Keel block. Separately cast.	5,320
Double-flanged pipe .. .. Cast by firm B, 30/5/1945.)	87.40	5.23	3.78	3.40	Trace	Trace	1,180	13.12 12.00	10.0 12.0	Keel block forming integral part of casting.	5,300
83/7/5/5 *Gunmetal* .. .. Double-flanged pipe. (Cast by firm A, 12/2/1945.)	82.06	7.72	4.87	4.72	0.63	Trace	1,200	16.4	27.0	Keel block. Separately cast.	5,040
Double-flanged pipe .. .. (Cast by firm B, 30/5/1945.)	83.29	6.65	4.82	4.75	0.17	Trace	1,180	11.60 12.32	11.0 13.0	Keel block forming part of casting.	6,000
Double-flanged pipe .. .. (Cast by firm C, 4/11/1948.)	83.36	7.28	5.08	3.50	0.69	Trace	—	14.5 15.0	24.0 26.0	Keel block cast on	6,000[2]
Do.	84.25	7.12	3.38	4.15	0.83	Trace	—	13.0	16.0	Keel block cast on.	6,000[3]
Double-flanged pipe .. .. (Cast by firm C, 4/2/1949.)	80.	8.04	5.19	2.84	3.01	0.03	1,160	15.0 15.5	13.0 15.0	Keel block cast on.	6,944 6,272
Double-flanged pipe .. .. (Cast by firm C, 21/6/1949.) Scavenged with nitrogen for 5 mins. before pouring.	81.67	7.48	5.25	2.97	2.19	Trace	1,180	13.5	10.0	Keel block cast on.	7,600[4]

1 Machined 0.564 in. dia. with gauge length of 2 in.
2 Load required to produce first signs of permanent set found to be 3,800 lb. per sq. in.
3 Load required to produce first signs of permanent set found to be 3,600 lb. per sq. in.
4 Load required to produce first signs of permanent set found to be 4,700 lb. per sq. in.

During the war they also investigated the properties of high-tensile aluminium-bronze die castings (as shown in Table C and Fig. D). In those tests the die was preheated to 400 deg. C., and the castings stripped from the mould within one minute of pouring and allowed to cool freely in air. In view of the fact that the A.B.B.F. Report did not contain any tests on copper-base die castings, those results might be of interest.

Melting Data

DR. KONDIC said he would like to associate himself with the remarks made by Mr. Hudson as to the Report. He thought it was a really good Report which went far in the right direction. He hoped, like Mr. Hudson, that the work would be continued, and it was in that hope that he would put forward one or two suggestions rather than make any serious criticism.

First he thought that melting data should have been given so that the results of mechanical tests could have been related to the melting technique and practice. His second point related to the question of the test-bars, for he saw that different types of test-bars had been used. What was the basis on which the selection of the test-bar was made? His experience was that the term "standard test-bar" in the copper alloy foundry industry did not necessarily mean the latest standard test-bar. In the present case was the

TABLE B.—*Properties of Aluminium-bronze Propeller Castings in Relation to Separately-cast Test-bars (see Fig. C).*

Composition, per cent.						Test-bars cut from root of blade.[1]		Separately-cast test-bars.[2]	
Ni.	Fe.	Mn.	Al.	Si.	Cu.	M.S., tons per sq. in.	E., per cent.	M.S., tons per sq. in.	E., per cent.
3.87	4.34	0.90	8.70	0.07	Bal.	39.0 42.5	20.0 26.0	41.6	15.0
3.83	4.07	0.52	9.61	Nil.	Bal.	47.5 46.0	34.0 35.0	42.4	16.0

1 Machined 0.179 in. dia. with a gauge length of 0.63 in.
2 Machined 0.564 in. dia. with a gauge length of 2 in.

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Keel test-bar used for all the different types of alloys? Their experience at Birmingham led them to believe that there was no single design of test-bar which was suitable for all the copper-base alloys. The third point was that of the moulding sand used for test-bars. Was it the same sand and the same mould dressing as were used for making the actual casting?

THE CHAIRMAN said that where there was a large number of members of an Association contributing to a research, the same measure of control could not exist, and to have tried to have postulated such conditions would have limited the investigation.

were supposed to give some indication of melt quality.

Cast-on Test-piece

MR. THOMPSON spoke of his experiences with hydraulic castings with regard to test-bars, and said he had tried out or one two experiments of his own. With metal having a temperature of 1,200 deg. C., he found that the highest tensile strength depended on the shape of the test-pieces. The idea behind the tests was that the metal was a little bit dull and there was the chance of the Keel bar coming up. They also conducted an experiment with the cast-on test-piece on the head inside the box. The inside test-bar showed the better properties. He had felt for a long time

TABLE C.—*Properties of Aluminium-bronze Gravity Die-cast Selector Forks (see Fig. D).*

Composition, per cent.					Properties of tensometer bars.[1]		V.D.H. 30 kgm. load.
Ni.	Fe.	Mn.	Al.	Cu.	M.S., tons per sq. in.	E., per cent.	
5.01	0.34	0.49	8.26	Bal.	35.5	18.0	171
(5)	(0.4)	(0.5)	8.65	Bal.	38.0	14.0	192
5.20	0.38	0.61	9.17	Bal.	44.3	12.0	220
(5)	(0.4)	(0.5)	9.65	Bal.	47.2	9.0	240
(5)	(0.4)	(0.5)	10.07	Bal.	49.5	9.0	275
(5)	(0.4)	(0.5)	10.57	Bal.	48.5	5.0	272
5.11	1.78	0.58	7.87	Bal.	29.0	26.0	—
(5)	(2)	(0.5)	7.92	Bal.	34.5	19.0	—
(5)	(2)	(0.5)	8.20	Bal.	35.0	18.0	—
(5)	(2)	(0.5)	8.38	Bal.	36.0	19.0	—
4.95	5.85	0.52	7.87	Bal.	30.0	18.0	190
(5)	(5)	(0.5)	8.14	Bal.	36.0	15.0	194
(5)	(5)	(0.5)	8.40	Bal.	42.5	13.0	211
5.52	5.21	0.54	9.20	Bal.	48.5	13.0	240
(5)	(5)	(0.5)	10.17	Bal.	54.5	7.0	270
(5)	(5)	(0.5)	10.65	Bal.	57.5	6.0	290
(5)	(5)	(0.5)	11.22	Bal.	63.8	6.0	296

Figures given in brackets are nominal compositions.
1 Machined 0·179 in. dia. with a gauge length of 0·63 in.

MR. EVANS said he did not know whether the work was ever published, but there had been an attempt to make a type of test-bar which would be standard for all copper-base alloys. The British Standards Committee, however, finally decided to have two types of test-bar, the Keel bar and the so called "grid-iron" type, both illustrated in B.S.S. 1367.

It had been impressed on members of the A.B.B.F. who participated in the experiments that mould materials for the test-bars should be the same as for the casting, in conformity with common practice, and as laid down by B.S.S. 1367.

Dr. Kondic had suggested that melting data should have been given. The Committee had considered this but decided that the details would have been difficult to collate and tabulate, and had compromised by giving a full analysis, where available, of each specimen. In any case, details of melting conditions would fail to give a direct answer as to the gas content of the metal and the other imponderables which were controlled largely by melting conditions. There was as yet no direct method of measuring the gas content of a melt, although the standard test-bars

that this test-bar business was getting beyond them. He could not understand why the inspectors insisted on a cast-on test-piece.

MR. EVANS replied that he agreed with all Mr. Thompson had said, but would refer him to B.S. 1367 (P.8), which sought to demolish the idea that cast-on test-bars gave a measure of the soundness of the casting. To obtain the optimum results for a test-bar a fixed casting temperature was necessary. The casting itself might be 20, 40 or 50 times the weight of the test-bar, and to obtain the casting sound a completely different casting temperature was necessary. With cast-on test-bars, therefore, it was a question of choosing between having the test-bar or the casting sound.

All this had been discussed fully on the B.S.I. committee which drafted B.S.S. 1367, and on this committee there were representatives for industry, inspection organisations and research organisations. The case for cast-on test-bar had now been finally demolished.

MR. THOMPSON asked Mr. Evans if he favoured the Keel or the grid-iron shaped test-bar?

MR. EVANS replied that the Committee favoured

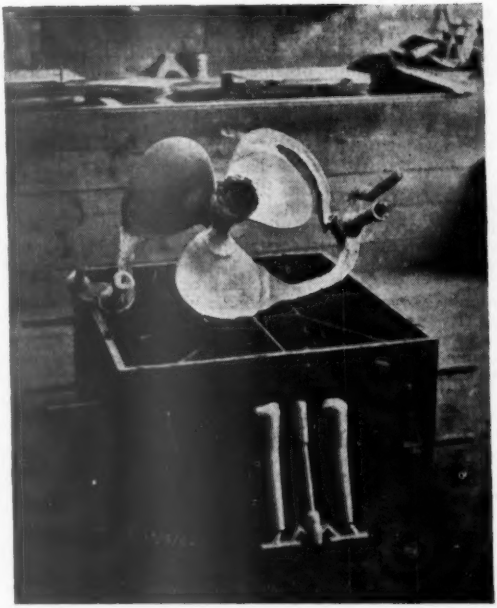

FIG. C.—GATING AND FEEDING METHODS EMPLOYED FOR ALUMINIUM-BRONZE PROPELLERS. (DIA. OF PROPELLER APPROX. 30 IN.)

the latter for gunmetal, the Keel bar type being recommended for the high-shrinkage alloys such as the aluminium-bronze and high-tensile brass.

Inspectors' Doubts

MR. REYNOLDS said that inspectors doubted the honesty of firms in supplying separately-cast test-bars. If a firm's integrity could be relied on, he did not think this point would arise at all. He remembered in his early days seeing separately-cast bars tested and then duplicates burned on the casting. In later years he made inquiries and found that the practice was indulged in by some foundries, although he was pleased to say his own company had never followed the practice.

There was one question about Case No. 13 he wished to raise, for it seemed to him that to cast it in this way, with a riser on the top of a circular face made the casting difficult to feed, and the riser difficult to remove. The job, he thought, would be better cast the other way up or by moulding it on edge. It would be much easier to feed that way than by the method presented.

His foundry, which was over 40 years old, was in recent years using aluminium bronze to a great extent and with great advantage, and he would like to recommend to the Committee that it should consider not merely the methods of making castings and the question of the test-bar alone, but what was the best type of metal for a particular job. Aluminium bronze was found to be stronger and harder than gunmetals and they were able to withstand high hydraulic pressure, through its use. A parallel might also be drawn between aluminium bronze and high-tensile bronze. Manganese bronze had greater electrical conductivity than aluminium bronze, while the latter had greater fatigue strength. If the Committee was to deal with these particular questions, and gave them some guidance, he thought much benefit would be derived. He had no axe to grind with the mechanical engineers and inspectors, but he had found there was a certain amount of conservatism about trying out these or any new metals. When they read a Report like this and they did not find that the metals them-

FIG. D.—ALUMINIUM-BRONZE DIE CASTINGS SHOWING METHOD OF RUNNING AND POSITION OF TENSOMETER TENSILE TEST-PIECES.

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selves were dealt with, they were naturally disappointed. It was his opinion that guidance was more likely to be accepted from a committee than it was from an individual member of a firm.

MR. EVANS replied that he could not comment on the method of manufacture of Case No. 13 as the Committee had no control over the way the castings were made. All it had asked was that members should take a typical casting from production and not make it specially. Members were asked to section it up and give the Committee details of how it was made. It that way the Committee hoped to get the mechanical properties of typical castings as manufactured in British foundries to-day.

With regard to the last point about making some recommendations in respect of an alloy for a particular service, while that was an interesting suggestion he did not think they could possibly have been brought into the Report. The Committee could not consider what the casting was going to do, and in most cases it did not know. Each casting was regarded as a typical shape in a particular alloy. The question of recommending a particular alloy for a particular service was quite outside the scope of the Report.

Mechanical Properties Given

DR. KONDIC said they had no inspectors to contend with in the laboratory and they were able to look on this question of a standard test-bar from a different point of view. What were the properties that a test-bar should give? They had experimented with a gunmetal ingot. They cast it, rolled it out and then found the mechanical properties of the rolled annealed product. A test-bar, provided it was cast from a good quality metal, should give the mechanical properties approaching those obtained for the rolled material. When the design and casting procedure of a test-bar were carried out in conformity with the above principle, it was found that the test-bar became also sensitive to the metal quality. And this was precisely the information that the test-bar was supposed to provide.

MR. EVANS said that there were obviously certain difficulties about putting such a test-bar into general practice and recommending it. Apart from the difficulty that there were certain alloys which it was impossible to roll, they had to find a method which would also reflect in some degree the quality of the mould as well. As Dr. Kondic would realise, a completely sound gunmetal casting was impossible in a sand mould. So, after a long discussion, the B.S.I. committee had recommended that the test-bar should be made in such a way that it was a compromise between the metal quality and the mould quality. Dr. Kondic's test-bar, though scientifically correct, would not be suitable for a sand foundry.

THE CHAIRMAN thanked Mr. Evans on behalf of all present for the able manner in which he had dealt with the questions.

MR. EVANS, in reply, said that he was only the mouthpiece of the Committee, but he was glad that the Report had received some measure of success. He also thanked Mr. Hudson for his remarks, which he assumed were the official views of the Institute of Foundrymen, and would take an early opportunity of reporting them to the Technical Committee of the Association of Bronze and Brass Founders.

News in Brief

A 30-FT. LONG chilled-iron casting for a calender roll has left the London Road foundry of Miller & Company, Limited, Edinburgh, on the first stage of its journey to Canada. It weighs just over 10 tons and is 20 in. in diameter.

THE BOARD OF TRADE announces that Orders have been signed freeing certain goods from price control. The Orders will come into operation on September 26. Among the goods affected are the following:—Domestic hollow-ware—aluminium, stainless steel, copper, brass, and plated; such domestic heaters, refrigerators, cooking, washing and cleaning appliances, and lamps (except oil lamps) as are still subject to control; bakery machinery.

STATING THAT library facilities in science and technology were a disgrace to Britain, Dr. Percy Dunsheath, in his presidential address to the Association of Special Libraries and Information Bureaux conference, which opened at Ashorne Hill, near Leamington Spa, called on the Government for a new library in the centre of London "conceived on a grand scale." The best technical library in the United Kingdom, the Patent Office Library, in London, which formerly kept open until 10 p.m., now closed at 6 p.m., said Dr. Dunsheath.

LORD MCGOWAN, chairman of Imperial Chemical Industries, Limited, formally opened the company's group of new factories at Wilton, near Middlesbrough, last week. The factories already erected represent not quite half of a project which is expected to be completed by 1952. A tunnel running beneath the River Tees will carry pipelines linking the new factories with the I.C.I. works at Billingham on the Durham side of the river 12 miles away. Plants already in operation are for the manufacture of "Perspex" sheeting and phenol formaldehyde.

BRITISH LEADERSHIP in liquid steel temperature measurement by the "quick immersion" thermocouple technique is to be the subject of a Paper to be presented at the forthcoming 7th Annual Conference on Electric Furnace Steel to be held by the American Institute of Mining and Mechanical Engineers in Pittsburgh. Members of the British Steel Founders' Association have assisted the author of the Paper—Mr. J. F. B. Jackson, of David Brown & Sons (Huddersfield), Limited, provided data indicating the extent to which quick immersion pyrometry is applied in the British steel castings industry.

Company Results

(Figures for previous year in brackets.)

QUIRK, BARTON & COMPANY—Interim dividend of 2½% (same).

BRITISH ALUMINIUM COMPANY—Interim dividend of 4% (same).

ELECTRIC FURNACE COMPANY—Final dividend of 4½% (same) on the ordinary and preferred ordinary shares, making 8% (same).

FODENS—Net profit for the year ended May 31, £60,098 (£58,600); from taxation reserve, £25,000 (nil); dividend of 10% (same); to general reserve, £35,000 (same); to stock and general contingencies reserve, £30,000 (nil); forward, £22,092 (£23,239).

DOBSON & BARLOW (SECURITIES)—Investment income for the year to June 30 from Textile Machinery Makers, Limited, £13,500 (same); other income, £4,251 (£5,241); to income tax, £7,987; tax repaid, £555 (£464); fees, £11 (same); tax reserve not required, nil (£188); to management expenses, £402 (£408); directors' fees, £400 (same); profits tax, £449 (£525); net profit, £9,079 (£9,632); dividend of 9d. (same); forward, £7,852 (£7,032).

BRITON FERRY STEEL COMPANY—Trading profit for the year to April 2, £236,042 (£253,263); investment income, £17,198 (£17,388); to taxation, £102,000 (£126,000); depreciation, £74,789 (£73,018); charges in respect of 4% first mortgage debenture, £15,950 (same); pensions and allowances, £6,550 (£6,053); auditors, £945 (£682); directors' fees, £2,500 (£2,000); cost of trade investment written off, £4,000 (nil); net profit, £46,506 (£46,948); amounts receivable in respect of deferred repairs, nil (£14,123); final dividends from subsidiary companies, nil (£8,235); provisions not required, £309 (£20,022 and £14,123 receivable deferred repairs); brought in, £80,006 (£57,449); dividend of 15% (same); to general reserve, nil (£30,000); forward, £90,050.

BARTON & SONS—Group trading profits (including £14,800 profit relating to an earlier period) for 1948, £325,684 (£238,097); income from investments, £4,707 (£2,553); sale of investments, £993 (nil); surplus on realisation of capital redemption policy, nil (£922); to depreciation of fixed assets, £50,385 (£28,719); emoluments of parent's directors, £14,725 (£14,710); remuneration of auditors of parent, £750 (£500); staff pension and life assurance, £4,156 (£4,039); mortgage interest, nil (£510); capital increase expenses written off, £75 (£248); tax, £166,873 (£116,203); leaving £94,420 (£76,643); brought in, £28,740 (£30,053); transfer from capital redemption reserve, nil (£8,472); written off and provision in respect of investments, £3,800 (£49,000); to general reserve, £61,368 (£18,000); preference dividend, £13,066 (£3,836); final ordinary dividend of 4%, making 7% (same); forward, £29,334 (£28,740).

Machine Moulding Film Strip

The latest film strip—No. 9—in the "Foundry Technique" series is now ready. The title is "Machine Moulding" and it deals with the various types of pattern plates; moulding boxes, machines and operations which are employed in the mechanical ramming of sand into boxes. There are 25 frames, the diagrams maintain the customary high standard, and for the first time actual photographs are embodied in the strip. The printed booklet of teaching notes underlines the cardinal factors that come into play in this type of foundry production. Strip No. 9, like its predecessors, has been produced by Educational Productions, Limited, with the co-operation of Newton Chambers & Company, Limited, and the Council of Ironfoundry Associations. The price of the strip with the lecture booklet is 12s. 6d. Copies are obtainable on application to the secretary of the C.F.A., at Crusader House, Pall Mall, London, S.W.1.

August's Steel Output Record

Holiday Influence Minimised

Steel production in August was again affected by annual holidays, as was the case in the previous month. Nevertheless, output last month, at an annual rate of 14,953,000 tons, was the highest ever recorded in August, the previous best being attained in August of last year, when production was at an annual rate of 14,117,000 tons. July output was at an annual rate of 12,695,000 tons.

Notwithstanding the record level of production reached last year, every month of the current year has so far exceeded the output of the corresponding month of 1948.

Pig-iron production in August was at an annual rate of 9,477,000 tons, against 9,048,000 tons in the same month of last year.

Latest steel and pig-iron output figures (in tons) compare as follow with earlier returns:—

	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate
1949—1st quarter ..	179,300	9,324,000	304,800	15,850,000
2nd quarter ..	183,800	9,559,000	306,600	15,944,000
July	177,400	9,224,000	244,100	12,695,000
August ..	182,300	9,477,000	287,600	14,953,000
1948—1st quarter ..	174,700	9,084,000	287,200	14,933,000
2nd quarter ..	182,000	9,464,000	294,700	15,325,000
July	171,300	8,908,000	232,400	12,084,000
August ..	174,000	9,048,000	271,500	14,117,000

Tube Investments' S. African Subsidiaries

Tube Investments, Limited, announces the formation of a new subsidiary, T.I. South Africa (Pty.), Limited, to assist generally in the promotion of the business interests of its subsidiary companies in that country. Major-General Sir Francis de Guingand has been appointed resident chairman and managing director of the company.

Tube Investments, Limited, also announces the acquisition of the factory, plant, and equipment of the Ace Cycle & Engineering Company, Limited, of Springs, near Johannesburg. This resulted from an offer made by the chairman of Tube Investments, Mr. I. A. R. Stedeford, during a recent visit to South Africa, on behalf of a further subsidiary, T.I. Cycles (South Africa), Limited, then in formation. The offer was accepted by shareholders, and Tube Investments' technicians are now at the works at Springs, which are being planned to produce cycles specially suited for South African conditions. Major-General de Guingand has also been appointed chairman of this company.

Problems in Bronze Foundry Practice

This Paper, by Dr. Austen J. Smith, associate Professor of Metallurgical Engineering, Michigan State College, was presented by Mr. F. Hudson at the 46th Annual Conference of the Institute of British Foundrymen, at Cheltenham earlier this year. It was published in the JOURNAL *for June* 23.

DISCUSSION

The CHAIRMAN read a contribution from MR. W. MOCHRIE, who wrote:—

Dr. Smith's review of the unknown factors in the "mechanics of solidification" helped to bring into perspective the wealth of recently-published reports on foundry researches. It was his desire to carry a little further Dr. Smith's suggestions relative to melt quality control. If the laboratory equipment necessary in the research identification of gases was indicative of that required in the ultimate use in the foundry, the valiant efforts of the investigators would prove no more beneficial than the post-mortem test-piece Dr. Smith so rightly decried. Laboratory equipment was not immediately available to the majority of foundries, but in any event, the accurate determination of gas contents would take time which the melting period would not permit. The point he wished to stress was the need for a qualitative test of the melt *before* pouring.

Some years ago, prior to the pouring of a fairly expensive casting in nickel silver, he had resorted to the ancient copper smelting poling check in an open-top ingot mould. That proved satisfactory, to the extent of obviating a certain scrap casting, and the test had since been repeated for that alloy, as well as for copper for electrical-conductivity castings and cupro-nickel rolling slabs. He visualised the adoption of a shape more sensitive than the open-top ingot mould to form the basis of a test for all those alloys which were particularly prone to gas pick-up.

So far as fracture tests were concerned, for which again it was not necessary that the furnaceman should be a Bachelor of Science, these had been carried out regularly in this country in checking homogeneity. They had also been used for routine reverberatory-melt tests in brasses and other copper-zinc alloys. He was, however, pessimistic so far as the tallying-up of fracture appearances with tensile tests was concerned. As it was at present carried out, the fallibility or otherwise of a fracture test was no more or less, so far as he was aware, than the fallibility of the operator. Short of the use of a scaled microscopic screen in conjunction possibly with a coloured photographic standard (which in his opinion was not altogether desirable), it was difficult to visualise a standard that could be adopted throughout the industry. It was, therefore, with a very keen interest that he awaited the results of the A.F.S. research project.

DR. KONDIC, of Birmingham University, said he welcomed this type of Paper because it fulfilled a useful purpose in that it narrowed the gap between the work of the scientist and the practical foundryman. The rate of progress in metallurgical science was such that the gap between the two was likely to become wider rather than narrower. There were, however, a number of points in the Paper that needed re-examining, as, for instance, the question of the fine crystals that were described as forming the surface of a casting (Fig. 1). Those fine-crystal structures had been described many times in the past and attributed to the phenomenon of under-cooling. Dr. Smith now also subscribed to that view. Personally, after a long search in metallurgical literature, he himself had come to the conclusion that that particular explanation belonged to that class of explanations of metallurgical phenomena which someone at some time inserted in a text-book, where it had a habit of staying for a very long time. It was then read so often that it came to be generally accepted as accurate. Personally, he had yet to find the under-cooling theory experimentally proved, in so far as this was used to account for different structures in a casting.

There had been a recent development in respect of the nucleation of metallic liquids. The data available provided much better ground for the explanation of the fine surface structure. As there was not sufficient time available in the discussion to deal with these new developments, he had brought with him a sample aluminium casting where different types of surface crystals were obtained by varying, for example, the type of mould dressings. That was only one small point to illustrate the general fallacy of the under-cooling theory. He then referred to the doubt expressed by the Author on page 40 of the Preprint as to whether it was possible from the present knowledge to design a test-bar which would represent the metal in the pot as the mould was poured. This pessimism was hardly justified. There was, in general, for every type of alloy a suitable design of test-bar which was metal-quality sensitive. The trouble began when one design of the test-bar was used for alloys of differing casting characteristics and when insufficient precautions were taken in casting the test-bar. When these points were borne in mind, reproducible and accurate results could be obtained with the test-bar, which bore, at the same time, a direct relationship to the quality of metal.

Microporosity and Pinholes

MR. REYNOLDS said that, while the metallurgist had plenty of time for his research work, the foundryman was often conditioned by circumstances which he could not control. His first consideration would be at what temperature could his castings be safely run? For instance, his firm had to cast thin-sectioned castings at far above the critical temperature. The average foundry-

Problems in Bronze Foundry Practice

man was anxiously concerned with avoiding shrinkage and hot-tears, but in trying to do that he very often got microporosity.

He would like to ask Mr. Hudson a question which he, with his wealth of knowledge, would no doubt be able to answer. When they were making roll bearings, they found they got better results by using red lead instead of ingot lead, and the castings without the addition of nickel were a complete success. They also found that the best way to keep out the dross was to use dross traps.

MR. HUDSON replied that he was particularly interested to hear of this experience with regard to red lead. He thought that the explanation was that, when the metal was melted, the red lead-oxide gave off oxygen which reacted with hydrogen and the lead which was produced went into the metal.

MR. C. ROBERTS referred to subcutaneous blowholes and said that the metal in its molten state chilled on the top surface and in consequence the gas rose as high as it could. It could, however, not get to the very top, but remained slightly below the surface, thus perhaps causing the pinholes to appear.

MR. HUDSON said, with regard to this possible explanation, he did not think that the presence of mould gases could be overlooked.

Mechanism of Solidification

MR. REYNOLDS said that immediately the metal touched the mould faces, it formed a skin. The skin was not broken again and consequently all the gas was not eliminated. Would it not be possible by putting on more pressure to force the gas beyond the skin instead of leaving it just beneath it?

MR. HUDSON said that there were many factors in this problem. He had in mind the question of mould reaction. The metal could be poured so cold that solidification was inclined to be instantaneous. Yet they would still get some of these blowholes beneath the skin. They penetrated so far and then the whole casting solidified. Many arguments could be put forward as to the cause. They had to list them all before they got a rough idea of what it might possibly be.

MR. THOMPSON said that, after machining and nickel-plating had been applied to the surface, the pinholes showed up very small. They even withstood hydraulic pressure. The trouble had been going on for years.

MR. HUDSON said he thought that it could be assumed that the holes were really due to microporosity which could not be seen easily with the naked eye. When the casting was plated with nickel or chromium, the plating solution penetrated into these very fine cavities and, after the plating operation, they became exposed. For good plating there must be a solid surface. One first had to make sure that the metal was absolutely sound. The only way to do that was to ensure that the metal was completely de-gassed during melting and that afterwards it did not pick up hydrogen from water vapour in the mould.

MR. KEEBLE, as one primarily concerned with aluminium yet always closely interested in the trends and developments in other fields of foundry activity, said that he was impressed, in reading Dr. Smith's Paper, by the fact that in essence his problems were the same as those facing the aluminium-alloy people and were concerned with grain size, gas content, crystallisation habit, physical features of shrinkage, etc., effect of impurities and, possibly, with mould reactions. There was comfort in this thought, but also a moral to the effect that the boundaries between the various fields of founding were less substantial than often believed and it behoved the cast-iron founder to know what his colleague in the aluminium world was doing and "steel" man to be up to date with what his companion in the bronze world was thinking. The Institute afforded a common meeting place for this exchange of views.

With reference to the pinhole formation mentioned by Dr. Smith when dealing with leaded bearing bronzes, Mr. Keeble wondered whether this was an example of mould metal reaction, well known in the aluminium and magnesium worlds and discussed by Baker in his booklet "Shrinkage and Gas Effects," published by the British Non-ferrous Metals Association in 1944.

Pinholes Adjacent to the Core

MR. F. C. EVANS said that in fairness to Dr. Smith and the remarks which had been made about pinholes, it should be emphasised that the Author had definitely referred to pinholes adjacent to the core. When making a bush, it was found that the outside was quite sound, and it was only on the inside that there was a ring of blowholes within about one-sixteenth of an inch of the metal surface. It was to this particular phenomenon that Dr. Smith referred.

With regard to the question of dross formation, he believed there was a Committee of the Institute which was giving attention to the size and dimensions of gates. Anybody who had had to cast aluminium bronze knew that it was possible to devise a gating system whereby the metal was run into the lowest part of the casting and which filled the mould without turbulence and subsequent dross formation. The disadvantage of such a system was that, when the mould was filled, the hottest metal was in the bottom part of the mould and the coldest in the feeding heads. This unfavourable temperature gradient gave great difficulties in obtaining castings free from shrinkage cavities in an alloy with such high shrinkage characteristics as aluminium bronze.

Durville Method

On the other hand, there had been a method known for many years (the Durville method), by which the mould was filled with molten metal from the top, without turbulence, by a tilting procedure. In this method the molten metal in the mould had practically no temperature gradient from top to bottom, thereby helping the satisfactory feeding of the casting, especially if risers with large tapers be used.

(*Continued on p.* 388, *foot of col.* 2.)

Late Mr. A. J. K. While

Mr. F. Arnold Wilson writes:—Mr. Arthur J. K. While, chairman and managing director of G. & R. Thomas, Limited, Bloxwich, Staffs, who died last week at the age of 73, started his apprenticeship at the age of 17 at the Barrow Hematite Steel Company, Limited, where his father was managing director, and where he afterwards became chief chemist and assistant blast furnace manager, and then general assistant to his father. In 1902 he was appointed blast furnace and steelworks manager of Palmer Shipbuilding & Iron Company, Limited, Jarrow-upon-Tyne, where he remained until 1909 when he accepted the position of general works manager of the Barrow Hematite Steel Company, Limited.

In 1917 Mr. While became steelworks and blast furnace manager of Alfred Hickman, Limited, Bilston —now Stewarts & Lloyds, Limited—leaving eight years later to take an active part in the management of the Charcoal Iron Company, Limited, Lakeside, Windermere, which concern he had purchased in 1917. In 1935 he purchased the blast furnaces of G. & R. Thomas, Limited, which he managed with two of his sons.

Mr. While was a life member of the Iron & Steel Institute and the Staffordshire Iron & Steel Institute. He was an active member of the Blast Furnace and Refined Iron Section of the South Staffordshire Iron and Steel Trades Association and also of the Cylinder and Refined Iron Makers' Association. He was on the executive committee of the Council of Iron Producers and the Joint Iron Council.

He is survived by his wife and three sons, the eldest of whom is an executive of United Steel Companies, Limited, while his wife and his two younger sons are all directors of G. & R. Thomas, Limited. Mr. While's long experience and intimate knowledge of the iron trade have always been of the greatest use to his colleagues on the councils of the many associations whose meetings he regularly attended. His kindly nature won him a host of friends who will now very much miss him.

International Combustion Limited

The objects of I.X.C., Limited, which has been registered as a private company with an authorised capital of £1,500,000 in £1 shares, are to acquire the main undertaking of International Combustion, Limited, and to carry on the business of designers, manufacturers, and builders of, and contractors and constructional engineers for, power plant of all kinds; to carry on the business of mechanical, consulting, civil, constructional, agricultural, and general engineers, gas, petrol, electrical, light and power, and hydraulic engineers, etc.

Sir George Usher, managing director of International Combustion, Limited, stated last week that the main step is the formation of an operating company in this country. Plans to be placed before shareholders are expected to include proposals for an exchange of shares into a holding company which will control the group of International Combustion interests, home and overseas.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference E.P.D. or C.R.E. can be obtained from the Commercial Relations and Exports Department, Board of Trade, Thames House North, Millbank, London, S.W.1.

DEPWADE, October 3—Provision, laying, etc., of about 4¼ miles of 3-in. to 5-in. cast-iron mains, for the Rural District Council. The Council's Offices. (Deposit, £2 2s.)

SOUTH AFRICA, November 10—Foundry machinery and plant, for the South African Railways. (Reference: C.R.E. (I.B.) 24201/49, Room 1086.)

SHARDLOW, October 1—Supplying and laying about 2,000 yds. of 6 in. dia. spun-iron pipes, etc., for the Rural District Council. Elliott & Brown, consulting engineers, Stanley House, Pelham Road, Nottingham. (Deposit, £3 3s.)

OSWESTRY, September 30—Supply and laying of 850 yds. of 4-in. cast-iron water mains, etc., for the Rural District Council. Mr. C. B. Barnes, engineer, Rural District Council Offices, Castle View, Oswestry. (Deposit, £2 2s.)

MANCHESTER, October 1—Cast-iron manhole covers, valve hydrant boxes, etc., and cast-iron pipe specials, for the Corporation. The Surveyor, Waterworks Offices, Town Hall, Manchester, 2.

AXBRIDGE, October 10—Supplying and laying of approx. 550 yds. of 3-in. spun-iron water main, etc., and approx. 1,057 yds. of 1-in. galvanised tube, etc., for the Rural District Council. The surveyor, Mr. H. B. Day, Council Offices, Axbridge. (Deposit, £1 1s.)

KETTON, September 29—Supplying and laying of about 1,000 yds. of 4-in. and 3-in. dia. spun-iron water main, etc., for the Rural District Council. Pick, Everard, Keay & Gimson, engineers, 6, Millstone Lane, Leicester (Deposit £2 2s.)

WAREHAM AND PURBECK, September 26—Supplying and laying approx. 2,020 yds. of 3-in., 4-in., and 6-in. dia. spun-iron water mains, etc., for the Rural District Council. The engineer and surveyor, Mr. A. G. Flatt, Westport House, Wareham, Dorset. (Deposit, £3 3s.)

Technology Scholarships in U.S.

The cost of some 50 post-graduate scholarships to be awarded for the study of technology at selected universities and technological institutions in the United States will be met from funds provided by the Economic Co-operation Administration. The awards are open to students who hold a good honours degree in pure science or technology and are now working in industry or research associations, or teaching in universities or technical colleges. The scholarships will provide for fees, books, and travelling expenses in the United States and a maintenance allowance of $1,800 a year. The cost of the return passage to the United States will be met from public funds.

Successful candidates will be expected to take up their awards in February, 1950. The awards will be tenable initially for a year, but may be extended for a second year. Full details are obtainable from the University Grants Committee, 38, Belgrave Square, London, S.W.1.

THE AIM OF THE National Institute of Hardware, inaugurated in London recently, is to produce the finest craftsmen in every aspect of the industry, says Major E. B. Holloway, of Birmingham, its first president. The address of the Institute is 191, Corporation Street, Birmingham, 4.

STANTON-DALE

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Designed to meet the demands of high quality castings, which are, strength, machineability, and resistance to wear.

All these can be secured by using Stanton-Dale Refined Pig Iron in your cupolas.

The above illustration shows a group of castings made by Messrs. Goodbrand & Co. Ltd., Stalybridge, Cheshire.

PROMPT DELIVERY

THE STANTON IRONWORKS COMPANY LIMITED NEAR NOTTINGHAM

Raw Material Markets

Iron and Steel

Order-books at the foundries, on the whole, demand a steady rate of production. Many orders for castings for export are still held in abeyance pending the issue of the necessary import licences, and increased activity will result when these licences come through. In the case of high-phosphorus pig-iron, the light foundries are taking up available tonnages and there is little left for stock after current needs have been satisfied. The low- and medium-phosphorus pig-irons for the engineering foundries are also fully absorbed, while there is a persistent demand for hematite. The refined grades of iron are sufficient to cover requirements and, in fact, parcels continue to be sent abroad.

Foundry coke is being delivered in satisfactory quantities and most consumers are able to place supplies in stock. Limestone, ganister, and ferro-alloys can be secured to requirements, but stocks of firebricks at the producing end are low, and deliveries are subject to sufficient notice being given.

The re-rollers are recording outputs in line with the capacity of their plant and the amount of labour available. They have commitments for home and export requirements which absorb their production. Deliveries of semis are reaching them from the Continent, which supplement the steady flow of supplies from home sources.

The demand for plates continues to be in excess of production, especially as regards thicknesses below ½ in., and for these extended delivery is indicated. Shipbuilders and tubemakers could absorb additional tonnages of both plates and sheets if they could be made available. The call for heavy sections, such as joists, channels, angles, etc., showns no sign of slackening, but in some quarters fairly reasonable rollings can be obtained for the larger sizes. Rail and wire plants are fully booked with orders for some time ahead, and the strip mills are similarly placed.

Non-ferrous Metals

Following the Chancellor's devaluation statement, sales of copper, lead, zinc, tin, and aluminium by the Ministry of Supply are being temporarily suspended from midnight on September 17. Announcing this on Monday night, the Ministry stated that orders posted on or before that date would be accepted at the prices ruling on that day provided normal conditions had been complied with. Orders posted after that day would be dealt with at the new prices when trading was resumed. Sales are being resumed to-day (Thursday) at new prices, some of which are listed on page 26. Copper is now priced at £140, lead at £122, zinc £87 10s., and aluminium £112.

The publication last week of the American copper statistics for August followed a week when interest by consumers in the United States had improved to a point where there was even a rumour of a price increase. Of late there has been a tendency to foresee a rise from 17½ cents to 18 cents per lb. in the price of this metal, and if this should happen the advance may be carried further. American production of blister copper in August was 62,449 short tons, against 62,569 tons in July, while the output of refined metal was 85,577 short tons, compared with 85,638 tons in the previous month. Deliveries showed a marked improvement, jumping from 45,316 short tons in July to 90,739 tons in August. Stocks did not show much change, and the August figure at 217,167 short tons compared with 212,817 tons at the end of July. Although it was realised that the delivery figures for June and July could hardly be representative of the true state of affairs in the United States, the August total of some 91,000 tons is very encouraging. Figures for August deliveries in the United Kingdom are not yet available, but they are awaited with interest, especially as the July total was rather poor. It is reported that there has been a good inquiry for export copper during the past week or so, and consumers in Britain are also buying fairly briskly.

In scrap there is little change to report; prices have continued to be very firm and, indeed, in some cases have reached a level at which consumers have turned to the use of virgin metal. Undoubtedly, the expectation of devaluation was responsible for much of the strength in secondary metals, and in view of the establishment of the new exchange rate it is doubtful whether there will be any setback in quotations *vis-à-vis* virgin metal prices.

British Steel Founders' Association

The British Steel Founders' Association is organising a technical convention to discuss the report of its Anglo-American productivity team, which is to be published shortly. The date and place of the meeting will be announced in the near future. The Association is also organising a series of visits of members of the productivity team to steel-foundry centres so that the experiences and the findings of the team can be made known to all in the industry. The team is the first to complete its report, a shortened version of which will be widely circulated in the engineering industry.

Problems in Bronze Foundry Practice

(*Continued from page* 385.)

The CHAIRMAN expressed the thanks of the meeting to Dr. Smith for drawing their attention to certain problems which required further investigation and research in connection with bronze-foundry practice, and he thanked Mr. Hudson for the very efficient way in which he had presented the Paper on Dr. Smith's behalf.

MR. HUDSON said he thought Dr. Austen Smith would be very gratified indeed when he received a report of the discussion on his Paper. American metallurgists were looking to this country for new advances in every branch of non-ferrous foundry research. They wanted to know what we had discovered about these problems.

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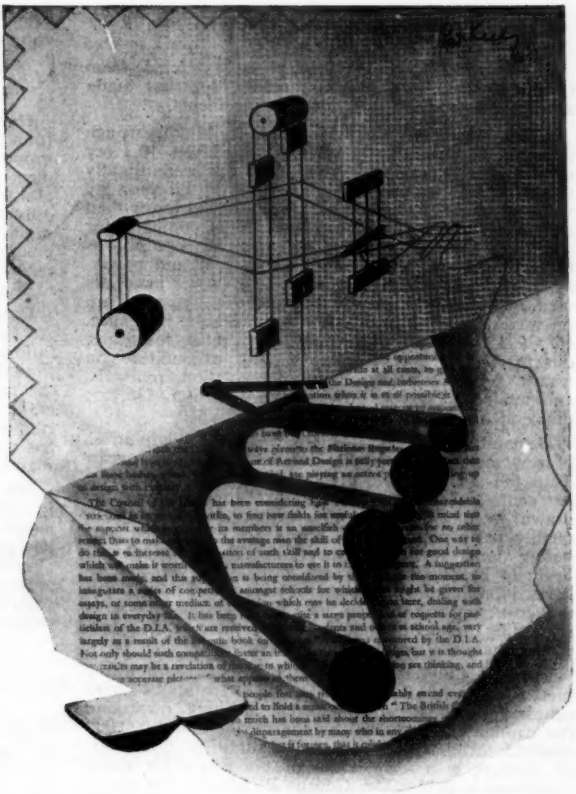

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Company News

The paragraphs below have been extracted from statements circulated to shareholders, speeches made at annual meetings, and other announcements.

Gjers, Mills & Company, Limited, Middlesbrough (MR. L. F. WRIGHT):—Output for 1948 was 10.3 per cent. higher than in 1947, but deliveries were slightly lower by 0.4 per cent. At the end of the year the value of our stocks and stores was £22,208 lower than at the end of 1947. The income of the company for 1948 was £1,253,473, which has been disposed of as follows:—Expenditure on purchasing fuel and power, £437,693; expenditure on purchasing all other materials used, including relining provision, £454,019; expenditure on wages, salaries, holidays with pay, N.H. insurance, etc., £215,378; expenditure on rents, rates, insurance, directors' fees, licences, etc., £7,020; expenditure on transit, £75,980; provision for depreciation, renewals, and retained, £14,748; provision for taxation, £36,755; dividend distributed to shareholders, £11,880.

Demand for products still remains high, but prices of raw materials have all increased during the year. Thus the average price of blast-furnace coke was 14.5 per cent. higher than in 1947, but attention must be drawn to the fact that no further deterioration in quality has occurred, and hopes are entertained that before long an improvement in this direction will begin to be obtained. Wages have also risen, but increased production has been obtained and as a result the cost per ton output has not increased. It is interesting to record that for every three people employed there are five registered shareholders.

Murex, Limited, manufacturers of carbon-free metals, etc., of Rainham, Essex:—Resolutions were unanimously passed at a recent meeting increasing the capital to £2,650,000 by the creation of 1,000,000 new £1 ordinary shares and capitalising £1,000,000 of reserves in a scrip bonus of one share for every £1 of stock held. Mr. George P. Joseph, the chairman, emphasised that members should not anticipate any immediate increase in the total amount distributed as ordinary dividend compared with recent years. We must continue, he said, to maintain a prudent financial policy, having regard to the heavy burden of taxation and the heavy cost of new construction and plant replacements.

Glover & Main, Limited:—An extra-ordinary general meeting is called for October 5 to increase the capital to £750,000 by the creation of 250,000 £1 ordinary shares and to consider the capital bonus of one ordinary share for every 10 held on October 5 and which will absorb 45,000 of the new shares. It is also proposed to revise the memorandum and alter the articles.

Atlas Steel Foundry & Engineering Company, Limited, Armadale, West Lothian:—The board recommends the issue out of reserves of 18,750 bonus shares of £1 each in the proportion of one new share for every £3 ordinary stock held on August 29. The shares are to be converted into stock units of 5s. each. The issued capital of £56,250 will thus be increased to the authorised total of £75,000. In 1935 the paid up capital was reduced from £75,000 to £37,500; it was increased to its present figure by a capital bonus of 50 per cent. in 1937.

Head, Wrightson & Company, Limited, engineers and foundrymen, of Thornaby-on-Tees:—The directors propose to capitalise the sum of £118,125 for the payment in full of 118,125 ordinary shares of £1 to be allotted on the basis of one new share for every four ordinary shares of £1 held. The issue entails the capitalisation of £107,144 standing to the credit of share premiums account and £10,981 part of the general reserve. The consent of the Capital Issues Committee to the proposed issue has been obtained.

Hattersley (Ormskirk), Limited, ironfounders, etc.:—At an extra-ordinary general meeting recently, resolutions were passed unanimously to increase the capital of the company from £250,000 to £500,000 by the creation of 250,000 £1 preference shares, and to make an issue to shareholders of 250,000 5 per cent. £1 cumulative preference shares as a free bonus on the basis of one preference share for every four ordinary shares held.

Hill Top Foundry Company, Limited, Wednesbury:—In order to bring the issued capital of the company more into line with the capital actually employed in the business, it is proposed that a bonus issue be made of three ordinary shares for every one ordinary share at present held. This will absorb £45,000 of the company's total reserves of £127,583, leaving £82,583 supporting the ordinary capital of £60,000.

Aluminium Production in Italy

Although the peace settlement has meant the loss, to Italy, of the Istrian bauxite deposits, which had formed the backbone of Italy's aluminium industry, the country's aluminium output of 33,000 metric tons last year reached the average of the years 1938-40. Compared with the previous year, output had risen by some 10,000 metric tons. Bauxite is at present derived solely from the Italian sources at San Giovanni Rotondo and at Cavone, in Foggia and Bari Provinces. The material mined in these localities is, however, somewhat inferior to that won in Istria and, moreover, production costs are much higher, partly on account of transport problems. Production amounts to about 170,000 tons per annum, necessitating the import of 50,000 tons.

The country's industrial programme envisages, *inter alia*, a considerable expansion of alminium production, and it is intended to invest some $50,000,000 to increase productivity. Of this sum, about $15,000,000 is to be spent on E.R.P. machinery. When this re-equipment programme is completed, it is hoped to reach an annual output of 45,000 metric tons, and, assuming that domestic requirements will aggregate from 35,000 to 40,000 metric tons, leaving a small exportable surplus.

Thermal Spalling can reduce the thickness of furnace walls very quickly. Even if complete collapse is not experienced, the thinning of the walls causes excessive heat liberation to the atmosphere with consequent furnace cooling.

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EXPORT AGENTS: GENERAL REFRACTORIES LTD., GENEFAX HOUSE, SHEFFIELD, 10

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered, unless otherwise stated)

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £10 4s.; Birmingham, £10 0s. 6d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £11 15s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si)—North Zone, £12 2s. 6d.; South Zone, £12 5s.

Scotch Iron.—No. 3 foundry, £11 18s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £12 14s. 6d.; South Zone, £12 17s.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £13 4s. 6d.; South Zone, £13 7s.

Cold Blast.—South Staffs, £15 16s. 6d.

Hematite.—Si up to 2½ per cent., S & P over 0.03 to 0.05 per cent.; N.-E. Coast and N.-W. Coast of England, £11 16s. 6d.; Scotland, £12 3s.; Sheffield, £12 9s.; Birmingham, £12 15s.; Wales (Welsh iron), £11 16s. 6d.

Spiegeleisen.—20 per cent. Mn, £17 8s.

Basic Pig-iron.—£9 17s. 6d., all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.)

Ferro-silicon (6-ton lots).—20/30 per cent., £25 15s.; 40/55 per cent., £32 10s.; 70/85 per cent., £49.

Ferro-vanadium.—35/50 per cent., 15s. per lb. of V.

Ferro-molybdenum.—70/75 per cent., carbon-free, 6s. 5d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, 1s. 3½d. lb.

Ferro-tungsten.—80/85 per cent., 6s. 6d. lb.

Tungsten Metal Powder.—98/99 per cent., 7s. 6d. lb.

Ferro-chrome.—4/8 per cent. C, £60; max. 2 per cent. C, 1s. 5d. lb.; max. 1 per cent. C, 1s. 5½d. lb.; max. 0.15 per cent. C, 1s. 6½d. lb.

Cobalt.—98/99 per cent., 12s. lb.

Metallic Chromium.—96/98 per cent., 5s. 1d. lb.

Ferro-manganese (blast-furnace).—78 per cent., £25 3s.

Metallic Manganese.—94/96 per cent., carbon-free, 1s. 9d. lb.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.—BASIC: Soft, u.t., £16 16s. 6d.; tested, up to 0.25 per cent. C (100-ton lots), £17 1s. 6d.; hard (0.42 to 0.60 per cent. C), £18 16s. 6d.; silico-manganese, £23 19s.; free-cutting, £20 1s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £22 4s.; case-hardening, £23 1s. 6d.; silico-manganese, £26 6s. 6d.

Billets, Blooms and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £19 16s. 6d.; basic, hard, over 0.41 up to 0.60 per cent. C, £21 1s. 6d.; acid, up to 0.25 per cent. C, £23 1s. 6d.

Sheet and Tinplate Bars.—£16 16s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Plates, ship (N.-E. Coast), £20 14s. 6d.; boiler plates (N.-E. Coast), £22 2s.; chequer plates (N.-E. Coast), £22 19s. 6d.; heavy joists, sections, and bars (angle basis), N.-E. Coast, £19 13s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £22 6s.; flats, 5 in. wide and under, £22 6s.; rails, heavy, f.o.t., £19 2s. 6d.; hoop and strip, £23 1s.; black sheets, 17/20 g., £28 16s.

Alloy Steel Bars.—1-in. dia. and up: Nickel, £35 6s. 6d.; nickel-chrome, £49 18s. 6d.: nickel-chrome-molybdenum, £55 0s. 9d.

Tinplates.—I.C. cokes, 20 × 14, per box, 41s. 6d., f.o.t. makers' works.

NON-FERROUS METALS

Copper.—Electrolytic, £140; high-grade fire-refined, £139 10s.; fire-refined of not less than 99.7 per cent., £139: ditto, 99.2 per cent., £138 10s.; black hot-rolled wire rods, £154.

Tin *(subject to revision when trading is resumed).*—99 to under 99.75 per cent., £569; 99.75 to under 99.9 per cent., £572 10s.; min. 99.9 per cent., £577.

Zinc.—G.O.B. (foreign) (duty paid), £87 10s.; ditto (domestic), £87 10s.; "Prime Western," £87 10s.; electrolytic, £88 5s.; not less than 99.99 per cent., £89 5s.

Lead.—Good soft pig-lead (foreign) (duty paid), £122; ditto (Empire and domestic), £122.

Zinc Sheets, etc.—Sheets, 10g. and thicker, all English destinations — — (Scotland and N. Ireland, — —); rolled zinc (boiler plates), —— —— —; zinc oxide (Red Seal), d/d buyers' premises, —

Other Metals.—Aluminium, ingots, £112; antimony, English, 99 per cent., £ —; quicksilver, ex warehouse, £18 10s.; nickel, £224.

The prices below were ruling before those of the base metals were raised and are subject to revision.

Brass.—Solid-drawn tubes, 20d. per lb.; rods, drawn 10¾d.; sheets to 10 w.g., 16½d.; wire, 16½d.; rolled metal, 14⅞d.

Copper Tubes, etc.—Solid-drawn tubes, 19½d. per lb.; wire, 144s. 9d. per cwt. basis; 20 s.w.g., — per cwt.

Gunmetal.—Ingots to L.G.2 (85/5/5/5), £77 to £90; L.G.3 (86/7/5/2), £80 to £118; Gl (88/10/2), £126 to £156 per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £126 to £170; L.P.Bl, £88 to £118 per ton.

Phosphor Bronze.—Strip, 22½d. per lb.; sheets to 10 w.g., 24½d.; wire, 24½d.; rods, 23d.; tubes, 27½d.; chill cast bars: solids, 23d., cored, 24d. (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 1s. 4½d. per lb. (7%) to 2s. 1d. (30%); rolled metal, 3 in. to 9 in. wide, × .056, 1s. 10½d. (7%) to 2s. 7d. (30%); to 12 in. wide, × .056, 1s. 11d. to 2s. 7½d.; to 25 in. wide, × .056, 2s. 1d. to 2s. 9½d. Spoon and fork metal, unsheared, 1s. 9½d. to 2s. 5½d. Wire, 10g., in coil, 2s. 3½d. (10%) to 3s. 0½d. (30%). Special quality turning rod, 10%, 2s. 2½d.; 15%, 2s. 7d.; 18%, 2s. 11d.

Visit to Sheffield Foundries

Two prominent American visitors to this country, Mr. P. D. Fahnestock and Mr. Webb Sparks, were the guests of the Sheffield Chamber of Commerce at a luncheon on Monday last. Mr. Sparks is assistant director of the National Association of Manufacturers of the United States. Mr. Fahnestock, who is in this country to study reactions to the Marshall Plan, is closely associated with the Anglo-American Council of Productivity.

During the morning of the same day, the visitors inspected the Sheffield foundry of Samuel Osborn & Company, Limited; the steelworks of Hadfields, Limited, and declared themselves to be much impressed by the evidence of team work and craftsmanship. They paid fine tribute to the work of Mr. F. A. Martin, O.B.E., managing director of Samuel Osborn & Company, Limited, as head of the steelfounders' productivity team, the first to visit the United States. During the afternoon the visitors toured the foundries of David Brown & Sons (Huddersfield), Limited, at Penistone, and, on the following day, the Sheffield works of the English Steel Corporation, Limited, and Edgar Allen & Company, Limited.

MR. R. W. JOHNSON has been appointed assistant managing director of Cammell Laird & Company, Limited, Birkenhead. MR. P. B. HUNTER has been elected an additional director, while MR. E. W. PARRY, assistant engineering manager, has been appointed a local director.

New Companies

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

WALTER BUTTON, Foundry Street, Crewe—Engineers, ironfounders, etc. £12,000. L. J. Button and C. K. Clines.

F. BRACEY & SONS OF BENINGTON, Benington, Stevenage, Herts—Agricultural engineers. £40,000. M. A., C. A., and J. F. A. Bracey.

G. D. THOMAS (REFRACTORIES), 14, Old Road, Llanelly, Carmarthenshire—£10,000. G. D. and A. G. Thomas.

CAMBRIAN FORGE & FOUNDRY, 74, Paradise Street, London, S.E.16—£20,000. A. K. Kirk, J. L. Graham, and R. C. Scott.

J. & J. MAKIN (METALS), Grosvenor Chambers, 16, Deansgate, Manchester—£100,000. J. R. Makin Pilling and J. Makin Kay.

Institution of Metallurgists

The Institution of Metallurgists held its refresher course, under the title, "The Fracture of Metals," at Ashorne Hill, Leamington Spa from September 16 to September 18. The following lectures were delivered: "Cohesion and Rupture in Metals," by N. P. Allen, D.Sc.; "Fracture in Creep," by R. W. Bailey, D.Sc.; "Brittle Fracture of Mild Steel," by W. Barr; "Fracture under Fatigue Conditions," by H. L. Cox; "Fracture Due to Stress Corrosion," by U. R. Evans, Sc.D.; "The Effects of Rate of Loading on Fracture of Materials," by C. Gurney, Sc.D.

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Situations advertised under this heading are available only to applicants excepted from the Control of Engagement Order, 1947, No. 2021.

SITUATIONS WANTED

IRONFOUNDRY FOREMAN (49) seeks position; experience in loam, dry and greensand, machine moulding, core blowing, rate fixing; general engineering work of all weights; highest testimonials as to abilities; expert on production.—Box 392, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGER (45) seeks sound position; 28 years' practical and executive staff experience; comprehensive knowledge, medium and light, general and machine moulded, iron, non-ferrous castings, for engineering and allied trades.—Box 394, FOUNDRY TRADE JOURNAL.

FOUNDRYMAN ENGINEER (25), Diploma of the National Foundry College, G.I.Mech.E., sound foundry and mechanical engineering experience (ferrous and non-ferrous), 2½ years' Naval engineer officer; any position of responsibility with good prospects considered.—Box 380, FOUNDRY TRADE JOURNAL.

PATTERNMAKER, 38, disengaged, desires progressive position, pattern-shop or foundry. A.M.I.B.F., City and Guilds, Foundry Practice and Science. Ability to design pattern equipment for mechanised production, general engineering machine tools and rapid repetition hand moulding. Experience in checking, works orders, etc. Knowledge of foundry technique.—Box 266, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

APPLICATIONS are invited for an EXECUTIVE appointment in the Commercial Department of a large and important group of Non-ferrous Foundries in the London area; the man appointed will be responsible to the General Manager for the administration of this department; applicants should possess a sound knowledge of modern sales administration, and be experienced in the preparation of quotations and general correspondence with customers; the position offers good prospects to the right man and is pensionable. —Write, giving details of age, qualifications, salary required and experience, in chronological order, to Box 340, FOUNDRY TRADE JOURNAL.

ASSISTANT FOUNDRY ESTIMATOR required for Malleable Foundry.—Write, with full details, experience, age and salary required, Box 360, FOUNDRY TRADE JOURNAL.

APPLICATIONS are invited for the position of WORKS MANAGER, to take charge of a small Foundry near Sheffield; qualifications required include absolute integrity, technical knowledge, sound practical experience and managerial ability; please give references, details of technical and practical experience, and state age, education and salary required.—Box 318, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

APPLICATIONS are invited for an unestablished post of SHOP MANAGER (FORGES) at a Ministry of Supply factory in S.E. London.

Applicants must have served a recognised engineering apprenticeship, preferably in, or closely associated, with the forging industry. They should either be corporate members of the Institutions of Civil, Mechanical, or Electrical Engineers, or have passed examinations exempting them from associate membership examinations. They must have had wide experience in production of all types of forgings, and be capable of controlling skilled and unskilled labour.

The successful candidate will be responsible for the production of heavy and light forgings, drop stampings and pressings over a wide range; and for the operation of gas, coal, coke and oil-fired furnaces.

Salary will be within the range £350/£600-£750 per annum inclusive, according to age, qualifications and experience.

Candidature will normally be confined to natural-born British subjects born in the United Kingdom or in a self-governing Dominions, of parents similarly born.

Write, quoting number C601/49/BW, to the MINISTRY OF LABOUR AND NATIONAL SERVICE, Technical and Scientific Register (K), York House, Kingsway, W.C.2, for application form, which must be completed by 15th October, 1949.

BRITISH CAST IRON RESEARCH ASSOCIATION invites applications from a wide field for three or four posts in a team to visit, examine, and advise ironfoundries on efficient production; leader experienced in management, executive control and costing; engineer for planning, power-aids and mechanisation; metallurgist; a fourth post might cover working conditions. In view of cardinal importance of choosing the right men, no salary ranges or limits are stipulated.—Applications, marked "Confidential," to DIRECTOR, Alvechurch, Birmingham, by 14th October, 1949.

CHEMIST AND METALLURGIST required by London High Duty Iron Foundry; applicants, preferably aged 25-30 years, should have good technical training, laboratory and foundry experience; ample scope for initiative and opportunity of advancement.—Full information and salary required to Box 374, FOUNDRY TRADE JOURNAL.

EXPERIENCED MANAGER required for Jobbing Foundry; capable of producing up to 10 tons per week of castings ranging from 7 lbs. to 30 cwt; able to estimate, rate fix, and take complete control; fine opportunity for man who can introduce Midlands methods; state age, experience, and salary required.—Box 370, FOUNDRY TRADE JOURNAL

SUPERINTENDENT, to control a small Steel Smelting Shop; experience with physical and metallurgical background, in refining of iron and steel, essential; practical knowledge of the operation of rotary furnaces an advantage.—Reply, stating age and experience and salary required, to Box 378, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

CORE SHOP FOREMAN for Light Alloy Foundry in Midlands; experienced in Motor, Aero and General Engineering work.—Apply, stating age, experience and salary.—Box 390, FOUNDRY TRADE JOURNAL.

EXCELLENT opportunity energetic practical FOUNDRYMAN, preferably already calling trade, sell new proposition interesting all foundries.—Box 952, FOUNDRY TRADE JOURNAL.

FOREMAN required by London Iron Foundry, to take full charge of production of medium and light jobbing work and machine moulding; about twenty moulders employed; must be familiar with piecework and bonus systems; strict disciplinarian required.—Replies, qualifications, salary required, in confidence, to Box 386, FOUNDRY TRADE JOURNAL.

FOREMAN required for Iron Foundry in the Manchester area; must be experienced in machine tool work, loose pattern, plate and machine moulding; knowledge of piecework prices would be an advantage.—Applications, stating age, full details of experience and wage required, to Box 382, FOUNDRY TRADE JOURNAL.

FOREMAN for a Foundry 20 miles west of London, preferably with experience in manufacture of high-class steel and non-ferrous castings; must be able to prove success in previous positions.—Applications in writing, stating age, full details of experience, and salary required, to Box V.236, WILLINGS, 362, Grays Inn Road, London, W.C.1.

FOUNDRY MANAGER required by important Company in Midlands; applicants should have had experience in the production of light iron castings in fully and partially mechanised foundries, and knowledge of core blowing, and should be capable of the successful control of labour, up to 600 male and female; the position is a responsible one and offers excellent prospects; the successful applicant would become a member of Company's Staff Pension and Life Assurance Scheme.—Apply in the first instance, giving particulars of age, qualifications, experience and salary required, to Box 358, FOUNDRY TRADE JOURNAL.

SALESMAN required for large Heavy Duty Iron Founders in the Midlands area, to work in London and the Southern area; applicants must be capable of reading drawings, and obtaining orders for repetition castings.—Replies, giving full details of career to date, to Box 376, FOUNDRY TRADE JOURNAL.

WANTED, for a Light Castings Foundry in the Devonshire area, a FOREMAN MOULDER; experienced in plate moulding; must be good disciplinarian; house provided.—Reply, giving particulars of technical knowledge,, experience, and age, to Box 400, FOUNDRY TRADE JOURNAL.